Giorgio Poletti

LEARNING-TEACHING PROCESS SUPPORTED BY INTERACTIVE AND MULTIMEDIA RESOURCE

Development of interactivity, accessibility and usability as elements or increasing the skills of the level of learning and specific skills in secondary school students



Presa Universitară Clujeană

Giorgio Poletti

•

Learning-Teaching Process Supported by Interactive and Multimedia Resources

Development of interactivity, accessibility and usability
as elements for increasing the skills of the level
of learning and specific skills in secondary school students

GIORGIO POLETTI

LEARNING-TEACHING PROCESS SUPPORTED BY INTERACTIVE AND MULTIMEDIA RESOURCES

Development of interactivity, accessibility and usability
as elements for increasing the skills of the level
of learning and specific skills in secondary school students

PRESA UNIVERSITARĂ CLUJEANĂ
2020

Referenţi ştiinţifici:

Prof. univ. dr. Nicolae Cristian Stan

Conf. univ. dr. Horațiu Catalano

ISBN 978-606-37-0947-0

Universitatea Babeş-Bolyai
Presa Universitară Clujeană
Director: Codruţa Săcelean
Str. Hasdeu nr. 51
400371 Cluj-Napoca, România
Tel./fax: (+40)-264-597.401
E-mail: editura@ubbcluj.ro
http://www.editura.ubbcluj.ro/

TABLE OF CONTENTS

TABLE OF FIGURES 9

TABLE OF TABLES 13

INTRODUCTION 15

CHAPTER I.
TRENDS OF DEVELOPMENT OF TOOLS
AND EDUCATIONAL TECHNOLOGIES 29

I.1. History and basic elements 29
I.2. Independence from devices and transversal skills 33
I.3. Technological trends and online tools 52
I.4. Reflection on the path of integration of technologies in teaching 59

CHAPTER II.
TECHNOLOGY AS RESOURCES AND RISK FACTOR
IN EDUCATIONAL PROCESSES 63

II.1. Introduction to the problem 64
II.2. Technological humus (background – substrate) 66
II.3. Description of the problem: instructing knowledge and educational experience 72
II.4. Analysis of a possible proposal: reduce risks and enhance benefits 77

CHAPTER III.
FROM CONSTRUCTIVISM TO METACOGNITION
FOR SIGNIFICANT LEARNING 85

III.1. Constructivism and metacognition 91

III.2. Significant learning and digital technologies to learn 98

CHAPTER IV.
REPRESENTATION SYSTEMS OF KNOWLEDGE:
AN EXPERIENCE OF REPRESENTATION OF AN ONTOLOGY 107

IV.1. Introduction 107
IV.2. Cognitions and representation 109
IV.3. Building, representing and browse ontologies: the EduOntoWiki tool 115
IV.4. Representation and navigation of knowledge: interfaces and new horizons 119
IV.5. Outcomes from the experimentation of environments for the generation and use of ontologies 122
IV.6. The fixed points with respect to the technology that emerged from the experimentation 125
IV.7. Relevant aspects of the interface 127
IV.8. The approaches tested at the interface 131
IV.9. Representation with a bidi-monthly visual approach 135
IV.10. Representation with a three-dimensional visual approach. 135
IV.11. Representation with textual wiki-documentary approach .. 138
IV.12. Open issues and research areas 139
IV.13. Learning Object, evaluation of artefacts 141

CHAPTER V.
TECHNOLOGY AS A FACTOR TO IMPROVE LEARNING; DEVELOPMENT
OF LEARNING SKILLS THROUGH THE USE OF INSTRUMENTS
FOR THE STRUCTURING OF KNOWLEDGE AND THE DETECTION OF DATA .. 151

V.1. Premise and context of research 151
V.1.1. General overview 151
V.1.2. The research 153
V.2. Research questions 158
V.3. Purpose and objectives of the research 163

V.4. Research hypothesis **165**
V.5. Research variables **176**
V.6. Sample of subjects **182**
V.7. Place, period and methods of conducting research **186**
V.8. Research methodology **187**
V.8.1. Quantitative Research 188
V.8.2. Research by Experiment 189
V.9. Research phases **190**
V.9.1. Pre-experimental phase 190
V.9.2. Experiment phase 191
V.9.3. Post-experimental phase 193
V.10. Tools used in research **195**
V.11. Intervention program **196**

CHAPTER VI.
RESEARCH'S FINDING 203

VI.1. Pre-experimental phase finding **203**
VI.2. Post-experimental phase finding **217**
VI.3. Reflections on empirical research **236**

CONCLUSION 241

General reflections **241**
Experimental program and interactivity of technologies ((hypothesis 1) **243**
Experimental program: usability and accessibility (hypothesis 2 and 3) **245**
Reflections on research limit and perspectives **250**

REFERENCE **259**

ANNEXES **265**

TABLE OF FIGURES

Figure no. I.1. Infographic of the evolution of educational technologies. 31

Figure no. I.2. Digital audience data in Italy 2014 (Source: IAB Forum one of the most important events on digital and interactive communication in Italy; the IAB Forum 2014 was held in Milan in November 2014. 36

Figure no. I.3. Semantic cloud of WEB 2.0 (Original by Markus Angermeier) (http://www.parkwayschools.org/students/hs_ms_media_center/web_2_0_resources)............ 39

Figure no. I.4. Learning environments (Ogata, Akamatsu and Yano: Computer Supported Ubiquitous Learning Environment for Vocabulary Learning using RFID Tags); the scheme considers the **level of mobility** (Level of mobility) and the **level of integration** (Level of embeddedness) (of the different types of learning environments. 46

Figure no. I.5. Development and comparison of tools, communication and learning methods in e-learning, m-learning and u-learning. (Source: Park, Y. (2011) A Pedagogical Framework for Mobile Learning: Categorizing Educational Applications of Mobile Technologies into Four Types, IRRODL, 12 (2)).............. 47

Figure no. I.6. Trace of the technological development of IoT (SRI Consulting Business Intelligence / National Intelligence Council - Appendix F of Disruptive Technologies Global Trends 2025 page 1)... 48

Figure no. I.7. A group of teenagers, most likely schoolgirls, on a trip, in a room at the Rijksmuseum in Amsterdam in front of "The Night Watch" by Rembrandt. Tweet by Gary Pikovsky (Source ilpost.it). 51

Figure no. I.8. Schematization of the graphic presentation presented in Smith's 2015 trends article (www.edtech magazine. com/higher/article/2014/12/10-online-learning-trends-watch-2015-infographic-0). 52

Figure no. IV.1. Scheme of the properties and values assumed by the conscious and cognitive unconscious. 112

Figure no. IV.2. Evaluation of the visual environment (from the questionnaire). The scale varies from 1 = Not at all satisfied to 6 = Completely satisfied. The lack of answers corresponding to extreme values is highlighted, to underline the difficulty of using an environment whose unexpressed potentials are felt. Values as a percentage of total answers. 131

Figure no. IV.3. Representation of an elementary lemma-relation-lemma bond, where visual and textual codes are used to synthesize the information necessary for understanding the bond itself. 132

Figure no. IV.4. The elements constituting the lemma-relation-lemma link are distinguished by code: on the left the textual codes and on the left the visual ones. 134

Figure no. IV.5. Two-dimensional visual approach (Example of a 2D map with link) - Labels are topics and branches are relationships. 136

Figure no. IV.6. Three-dimensional visual approach ((Example of a 3D map with link). Spheres are topics and branches are relationships 137

Figure no. IV.7. Wiki-documentary textual approach (description is in original language). 138

Figure no. IV.8. Usability reference system. 148

Figure no. V.1. Pedagogy Wheel (see https://designingoutcomes.com/english-speaking-world-v5-0_is in **CC,** as highlighted in the lower left corner of the image). 156

Figure no. V.2. Teachers divided by gender. 184

Figure no. V.3. Teachers divided by study level. 185

Figure no. V.4. Student, research group, divided by gender. 185

Figure no. V.5. Student, control group, divided by gender. 186

Figure no. VI.1. Section 1 of the questionnaire. 204

Figure no. VI.2. Section 2 of the questionnaire. 205

Figure no. VI.3. Section 3 of the questionnaire. 206

Figure no. VI.4. Data collected on the level and area of study of teachers divided by gender. 208

Figure no. VI.5. Data collected on school level and teaching area. 209

Figure no. VI.6. Use of technologies by student 216

Figure no. VI.7. Selection window for creating content that can be created in H5P. 218

Figure no. VI.8. Colored scale of pH levels. 227

Figure no. VI.9. Evaluation both experimental groups. 232

Figure no. VI.10. Evaluation both experimental groups. 232

Figure no. VI.11. Measured the level of understanding of the concept of pH 233

Figure no. VI.12. Evaluation both control group. 233

TABLE OF TABLES

Table no. IV.1. The phases of experimentation 124

Table no. IV.2. Prevailing both negative and positive aspects. The proposed ordering considers the "absolute value" of the items, positioning the aspects that have emerged several times over the top, considering both the negative and the positive connotations. 129

Table no. IV.3. Identification of the main operations, shown in order of importance, to be carried out in the environment to implement the different uses of the ontology proposed to the experimental groups. 130

Table no IV.4. Complexity that led to the transition to "traditional" tools. 139

Table no. IV.5. LOEM model. 144

Table no. V.1. Values of the characteristics of the cognitive conscious and the cognitive unconscious........................ 173

Table no. V.2. Dependent variables and methodological references. 180

Table no. VI.1. Data collected in the third section of questionnaire. 210

Table no. VI.2. Data collected in the third section of questionnaire bis 212

Table no VI.3. Data collected in first part of the questionnaire (Gender of students)... 214

Table no. VI.4. Data collected in first part of the questionnaire (Family study degree) 214

Table no. VI.5. Data collected related to devices owned or available.... 215

Table no. VI.6. Data collected related to type of use of devices owned or available. 216

Table no. VI.7. Difficulties encountered by students in using H5P environment. 219

Table no. VI.8. Help for difficulties encountered by students in using H5P environment. 220

Table no. VI.9. Tools used in H5p 220

Table no. VI.10. Considerable degree of communication in the products produced 222

Table no. VI.11. Average marks of the individual students of secondary schools in experimental group...................... 222

Table no. VI.12. Average marks of the individual students of secondary schools in control group 222

Table no. VI.13. Assesses the level of understanding of the concept of acid and basic (experimental group).............................. 224

Table no. VI.14. Assesses the level of understanding of the concept of acid and basic (control group). 225

Table no. VI.15. Difficulties encountered by students, in use of Arduino. 226

Table no. VI. 16. The strategy of solving problems encountered by students, in the use of Arduino. 226

INTRODUCTION

“Performing a critical and objective analysis of reality is always difficult, but when it comes to the world of children everything is complicated by a kind of nostalgia and impulse to confront what the age represented in our personal experience.

It is easy to expire in a moralistic reading of this mounting reality in our society.

I also believe that a local reading of the boys' world is lacking, because the widespread diffusion of the mass media and the consequent communication society has made this universe uniformly varied and more in need of valorization than of continuous analysis.

We are witnessing the multiplication of initiatives that various organizations dedicate to young people, but all too often they satisfy the need of an adult world that needs to feel itself to be a proposer, rather than the actual need to enhance the creative strength of young people.

However, I think that, regardless of the motivation, the open spaces, so that the boys can express themselves, show that this world is able to amaze and question us, which every time we propose initiatives dedicated to them, both of an educational nature. , recreational or cultural, today's reality, affirms its own vitality in its truest expression.

I believe that a careful look at the world of children can only lead us to a re-evaluation for what it is today and not in view of a future that will see them adults and then worthy of consideration.

The boys are not that mass of video-addicted, refractory to any reading or cultural stimulation as they have been defined in these years, but people with expressive canons and their own needs that try, rather

than to develop, to channel into understandable canons an adult world, with a completely unilateral interpretation of adaptation.

It is therefore a question of noting the lack of spaces dedicated to the children but the need for their restructuring.

A restructuring for a protagonist less and less wanted by adults and more and more lived by the boys.

In this way, talking about the world of children will no longer have the impression of referring to an antechamber of reality, but you will have the certainty without such a component no reality can be said complete." (Bulletin of the Diocese of Ferrara of September 1983, p. 3)

Rereading this small article that I wrote in 1983 (on the Bulletin of the Diocese of Ferrara of September 1983, p. 3) in relation to pastoral and catechetical actions I think that, subject to the modification and updating of some terms, it is opportune to reflect constantly on the relationship between technological reality and educational reality. It is also advisable to reflect on the guarantee that we can use every social change for an effective and constant didactic action, for an updating that of the teaching-learning processes, you know in the improvement aspects that in considering the risks they carry with behave.

Talking about updating does not mean following fashion or adapting to what is common feeling but maintaining a continuous attitude of research and innovation for an educational effectiveness of young generations, which are the object but also subject to social innovations.

The progressive increase in the use of multimedia and interactive platforms, including the world of social media, of mobile devices, which affects the new generations, must be considered.

This continuous and widespread use has generated a habit and a culture of access to many different paths of use of information strongly connoted as information from transmedia and cross-media characteristics.

The use of technologies and of these multimedia and interactive platforms shows how it is possible to integrate different media and use

them not only as a tool for access to information but as an added value of a strongly contextualized learning experience such as teaching-learning processes, making access to content in semantically defined ways.

All, the importance of the theme of the introduction of technologies in the teaching-learning processes goes beyond a simple "modernization" of the school but it is in its nature to be "contemporary" of its students.

No tool can be adopted without evaluating the pros or cons, but certainly, the study of technologies to support training processes is fundamental because technologies are a present and necessary skill to interact with reality.

The technologies are present and active in formal, informal and non-formal training environments and are questioning the way the school is.

The importance of the theme of the introduction and evaluation of technologies to support and integrate teaching-learning processes is underlined for the Italian school by the **PNSD** (**P**iano **N**azionale **S**cuola **D**igitale - *National Digital School Plan*) which is a guideline document issued by the Ministry of Education, University and Research.

PNSD promote and effectively support an overall strategy that has the innovation of the Italian school as its core.

This innovation aims to govern a new positioning in the Italian educational system that faces the challenge of the digital age.

The National Digital School Plan is the guideline and operational document for a law (Law 107/2015) which since 2015 has tried to regulate and face the challenges that the digital era has launched to the public administration and the entire civil society.

Law 107 also aims at an innovation of the school system to seize the opportunities that digital technology offers, both in terms of material production and in terms of building and managing learning communities.

The plan, as it was considered appropriate to consider the structure of the thesis, indicates a way to exit and evolve from the concept of digitalization on which these arguments have often been reduced simplistically.

No technology inserted in educational contexts can ignore, but rather must draw effectiveness and meaning from the epistemological and cultural dimension.

It is acknowledged and recognized that every educational process is indispensable to the constant and significant interaction between the teacher and each individual learner; technology cannot ignore or worse make the fundamental human relationship seem useless.

The **OECD** (**O**rganization for **E**conomic Co-operation and **D**evelopment) recalled and continues in its relations to underline this "interpersonal" aspect in the teaching-learning processes.

We are called to build a vision of education in the digital age, through a process that allows students to face, interpret and support a logic of learning throughout life (life-long) and in every context that we live: formal, informal and non-formal (life-wide).

This perspective is confirmed in the High-Level Conference of the European Commission (December 2014), and present in various publications for the Center for Educational Research and Innovation of the OECD, from the New Vision for Education Report of the World Economic Forum, and from the research "*Education for the 21st century*" of the Ambrosetti think tank.

This frame of reference and various training interventions for teachers of schools of all levels, as well as the training of future teachers and the theoretical and practical study of educational robotics, has led to the choice of this thesis.

It was considered important to understand and experiment how technologies, both online and physical ones, can be an effective tool in teaching-learning processes.

Schools are equipping themselves with technologies and often make a purely instrumental use of them, the importance of these themes in which the thesis is developed is the translation or updating of a motto I found myself sharing many years ago: "we must to move from the IT class to computer science in the classroom".

Motto is to signify that it was not a computer science laboratory (physical class) the key to understanding the evolution of the PC as a tool for learning, but the ability to give the ability to use a PC but in the classroom, that is integrated in the processes learning-teaching.

Now instead of "simple" computing, we have more technologies, more tools and their portability facilitate, if it does not stimulate, the use of the school "newspaper".

Above all, a paradigm shift can be read where learning gains the focus of the project, because it allows the student to be placed at the center, review, and formalize the teaching processes.

The challenge of education in the digital age can no longer only be a function of the amount of available technologies; rather, it must combine the growing availability of technologies and enabling competences, the rapid technological obsolescence and the new educational requirements.

Understanding this relationship means helping the school to acquire digital solutions that facilitate preparatory environments for active and laboratory learning, as well as for constructivist or project learning.

Education in the digital age must not focus on technology, but on the new models of educational interaction that use it.

These principles and reflections have meant that choices had to be made about how to tackle and conduct research.

The first choice that of the school order was guided by two considerations.

The first consideration is induced by the OECD[1] data relating to the first-year high school students that ranks the digital competences of the students, Italy is 25th in Europe for number of Internet users (59%) and 23rd for basic digital skills (47%).

This gap is also visible in the case of specialized skills on ICT (Italy 17th) and in the number of graduates in scientific or technological disciplines (**STEM** - **S**cience, **T**echnology, **E**ngineering and **M**athematics).

The same OECD report also says that every 15-year-old Italian uses the computer in class 19 minutes a day, against an average OECD of 25 minutes and peaks in Greece (42 minutes) and Australia (52).

For this reason, it was decided to carry out a research starting from the immediately preceding school cycle, in the perspective of a training that must precede and prevent, as much as possible, the problems related to the "triangle" student-tools-teacher.

The second consideration that has led the choice to the lower secondary school is that key words of the competences of the different disciplines are **understanding**, **classifying**, **using** and **describing**; skills that the use of technologies and their correct application, develop effectively.

By technology, a broad field of research will always be understood, in which various technical, scientific and humanistic disciplines are involved, which studies the application and use of everything that can be functional to the definition and solution of problems.

We then also reflected on the training process and its development, so it was decided to structure the research starting from an exploratory research done by giving teachers a questionnaire to understand if and how they perceived the change in cognitive styles with the advent of technologies.

---

[1] OECD (2019), OECD Skills Outlook 2019: Thriving in a Digital World, OECD Publishing, Paris, (https://doi.org/10.1787/df80bc12-en)

The surveys on a sample that reflects the composition of secondary school teachers for subjects taught and teacher training.

This survey has identified the ability to analyze and synthesize in the new cognitive styles that technology has induced.

The result is equalized for teaching areas, teacher training and teacher familiarity with the technologies.

Starting from these preliminary results, contact was made with a secondary school and an intervention was agreed with the decent, focusing on two areas of learning and trying, of course, to ensure that while having to obtain reliable data did not excessively influence the educational process in progress.

For the students the activities carried out were curricular, presented, and addressed with the commitment of students and teachers comparable to all the other activities done during the school year.

The research made use of a neutral tool such as survey questionnaires on behavior and opinions, of an anonymous nature and completed online (Google Modules) at school; some observation forms were used for teachers to better understand the experimental results and hypothesize future research perspectives.

The research sought to minimize the didactic impact as an "external" and "exceptional" event and using topics that better than others could highlight students' ability to analyze and summarize, with the help of computer and multimedia technologies.

A problem that must be kept in mind is the definition of the control group and the possible contamination with the experimental group.

Because the school has different locations, it has facilitated the overcoming of this problem as well as having a homogeneous teaching group allows to better evaluate the impact of technologies in the learning-teaching process.

The theoretical reflections and the choices made in the research setting have defined what is the structure and development of the thesis.

The theoretical part develops the relationship between technology and teaching, views from an epistemological and cultural point of view and from the key to understanding and adding value to technologies: interactivity.

In the first part of the thesis it begins by examining what is the development of technologies and what are the development trends that can be highlighted for educational technologies.

The analysis of these trends considers the tools and the social and cultural elements of the technologies, and their technological and methodological history.

The analysis of these trends considers the tools and the social and cultural elements of the technologies, and their technological and methodological history.

The historical analysis of educational technologies then leaves room for the concept of transversal skills and independence from devices; an independence necessary from a logical point of view, in order not to constrain the logics to the devices and increasingly highlighted by the speed with which the devices evolve and change, both hardware and software.

The last part of this first block analyzes the trends of didactic technologies and the impulse received as well as the relationship with all those that can be defined as online technologies.

The history of technologies, like the history of each new instrument, brings with it the eternal dualism between possibility and risk, especially for the most vulnerable or vulnerable subjects; since in this context we must deal with children, attention must always be high.

This block of the thesis therefore proposes an analysis and an introduction to the problem, its relationship with the technological background of the young people of today and an analysis of the problem

to propose a solution that, with attention to the problems knows how to exploit the undoubted advantages of technology both under the educational and socio-cultural aspect.

As mentioned in a study and research involving schools and technologies, one cannot ignore a perspective that involves epistemology, ontology and ethics.

Chapter III systematizes these aspects, correlating them with educational technologies and taking into consideration the influences and benefits that the same educational technologies inherit from their intertwining with constructivism and metacognition.

In this chapter we see how the concept of artifact as a tool for learning and abstraction has deep and well-nourished roots in thought and research in educational sciences.

It should be noted that constructing or using artifacts of which the logical structure is known helps in developing skills, which allow us to use what we know in every context that requires it.

Metacognition and the "theoretical" observation of technology introduces the concept of ontology, as a fundamental tool for the representation of concepts through technologies.

To describe this ontological approach to the representation of concepts through technological tools, a broad overview was given in Chapter IV of how concepts are represented; the concept of interactivity, benefit of digital educational technologies is relevant.

This description concludes with a definition of the concept of Learning Object and its evaluation in terms of accessibility, usability and satisfaction that are obviously applicable to the educational context.

The second part of the thesis that originates from the theoretical part, concluded with the description of the ontological aspect and of representation declined on the Learning Objects describes the development of the research.

In particular, the context and the premises of the research are described starting from the analysis of the models that catalog educational technologists, such as the SAMR model (Substitution, Augmentation, Modification, Redefinition), by use and innovation.

In this part, the three questions / reflections that guide the research are also introduced:

- *How much did technology change or influence cognitive styles?*
- *How much does the use of integrated technologies in teaching-learning processes modify their development and how much are they an advantage / disadvantage?*
- *How and how much the use and construction of cognitive artifacts improve learning abilities and skills development?*

The thesis continues with the definition of the research hypotheses, which can be summarized in the following points:

1. **test of a hypothesis**: the use of interactive technologies and cognitive skills increases the ability, by students, to develop both "cultural" and "relational" skills of the students themselves; for ***cultural skills*** in this context we mean the learning skills; the abilities that allow to understand contents and to re-elaborate them. By ***relational skills***, we mean, in this context, referring to the ability to communicate knowledge and use it to improve the ability to relate to other people.
2. **nomothetic[2] objective**: to define the didactic efficacy of cognate art forms, to define the rules of learning and inclusive of educational robotics methods and effect cognitive artifacts. In this context, the objective is defined in defining the parameters of interactivity, usability and accessibility as determinants for the evaluation of a cognitive artefact.

[2] It is called **nomothetic**, the objective of every investigation aimed at the search for general laws and the formulation of theories including whole classes of cases.

The thesis to continue with a description of the research methodology implemented and the tools used; for each phase of the research they are described and shown with tables and graphs, and the data collected are commented.

The sciences of education and in general all that concerns on the one hand the learning-teaching processes and on the other the tools that support these processes are so interconnected with what is the information society that it is difficult to measure the degree of novelty of a didactic and research intervention.

The reality of the Italian school is also such that the sharing of experiences is not in the culture of the teaching body and for this reason; it is complex even to hypothesize the degree of novelty or innovation of a research project.

With these premises, I believe that the novelty that can be identified in this research project is to make usable for educational technologies those indicators that measure the degree of usability, accessibility and satisfaction of those who use technologies to train or to learn.

The research I believe may have traced a path with which to train teachers in the use of technologies to stimulate and increase analytical and synthesis skills with respect to the subjects that students encounter in their study path, which skills and which knowledge are becoming predominant and essential for governing learning-teaching processes in the information age.

I also believe that research work can identify tools and technologies that had been reserved for "experts" to design paths where students learn how to retrieve information such as making them become skills and how to pass on acquired knowledge.

It can be said that from the point of view of knowing how to do research can explain the fact that in the world of technologies it is important to know the structure of knowledge and its sharing; a

knowledge that is nothing more than the ability to manage the data we acquire, understanding the relationships that unite them.

I believe that research can ensure that even for the sciences of education we can say what Albert-László Barabási says in introduction of his book Linked, The science of networks (2004, pg. 4) , where education surely configures a complex network:

"The good news is that, for some time, scientists have learned to draw the pattern of our interconnections. Their maps shed new light on the warp of our universe, offering challenges and surprises that were unimaginable until a few years ago.

Detailed maps of the Internet have revealed to the hackers the vulnerability of the system; financial reporting maps and owners of different companies have drawn the profile of power and money in Silicon Valley; maps of interactions between species in ecosystems have opened glimpses of human destructive impact on the environment; Maps of genes working together in a cell have enabled new discoveries on the mechanisms of cancer.

However, the real surprise came when these maps were placed side by side. We have seen that, just like humans who share almost indistinguishable skeletons, the different maps follow a common footprint. A series of breathtaking recent discoveries has confronted us with the fact that some far-reaching and incredibly simple natural laws govern the structure and evolution of all the complex networks that surround us".

The research that is done tries to define the possibility and effectiveness of the use of technologies as a teaching tool.

In particular, the impact it intends to have is to overturn a logic that sees technology as a subject of teaching, thinking of it as information technology or electronics.

The research wants to provoke a debate for an application of the concept of technology as an ability to describe an art.

We want to frame the technology by going back to its meaning, what is attributed to it by the Greek term deriving from the Greek "tékhne-logìa", literally "systematic treatise on an art".

An approach that finds its roots in the *Nicomachean Ethics* where Aristotle distinguishes two forms of action, prâxis and téchnē: while the former has its own purpose, the latter is always at the service of another, as a means. In this sense the "technique", a term often used as a synonym, was not different either from art, or from science, or from any procedure or operation capable of achieving any effect, and its field extended over all human activities.

The contribution that it intends to bring is to indicate through which technology, in a broad sense, as it also appears in the future, is integrated into the learning-teaching processes.

It is intended to make clear that technology is not just an aid to a "better" or "less fatigue" rate for a process.

Technology changes the approach to processes and people's approach to the reality around them, to understand and interact with it.

The practical impact is to include technologies in teaching and not have a classroom for technologies.

CHAPTER I.
Trends of Development of Tools and Educational Technologies

I.1. History and basic elements

The technological evolution that has characterized these last years has made its influence felt in every sector of the life of people and society, especially in the face of rapid evolution.

This evolutionary trend has evidently not left indifferent the world of education that has a double front on which to operate.

The methodological front that commits him to always integrate at best the tools of communication of the training-education process and a more pragmatic front on which it is faced with a widespread presence of technological tools used daily by students of secondary school and teachers.

The perspective from which we intend to observe, in this work, this phenomenon is not strictly methodological but that of analyzing how technologies have evolved and what perspectives have, both as educational technologies and as tools for generating content. .

The philosophy of approach to this analysis is that induced by the very meaning of the term, where we refer to the Greek term *τεχνολογία* (in Greek), a systematic treatise; an approach to technology and a trend analysis in the specific field of educational technologies seen as a sector composed of multiple disciplines.

The object of our reflection is the technology that has as its characteristic the use of technical tools, which can be both tools and knowledge, and their application for process optimization.

The technological evolution that has characterized these last years has made an effective analysis must also bear in mind that too often “technology” is a term used as a synonym of technique losing its intrinsic meaning of optimization of the set of techniques and knowledge of a certain field of knowledge.

This is the sense that fits perfectly with the context of educational technologies.

If one observes historically the evolution of educational technologies, according to a perspective of harmonization of the tools available to teachers, in most cases it is possible to notice that the students of secondary school live a reality that is significantly different from that in which their teachers have grown up. It is also clear that technologies have profoundly changed people's way of playing, learning and interacting with each other.

An interesting infographic[1] (See Figure no. I.1.) on the history of educational technologies was published in an article by Kawai Lai that, even if it describes the history related to the United States, represents well the parallel development of tools, use in the educational context and social challenges that have led.

Even the Italian situation can be well described by the time line delineated by Lai even though before the diffusion within schools of the instruments, and then the progressive recourse to educational technologies.

---

[1] The **infographic**, also indicated with the English phrases *information design, information graphic* or *infographic* is a technique that aims to communicate information in a more graphic and visual form than text. A notable example of this technique is the representation, made by Charles Joseph Minard in 1861, of the unsuccessful march on Moscow. Minard, in the graph, represent in a single two-dimensional image, four different variables of the failure of the military operation.

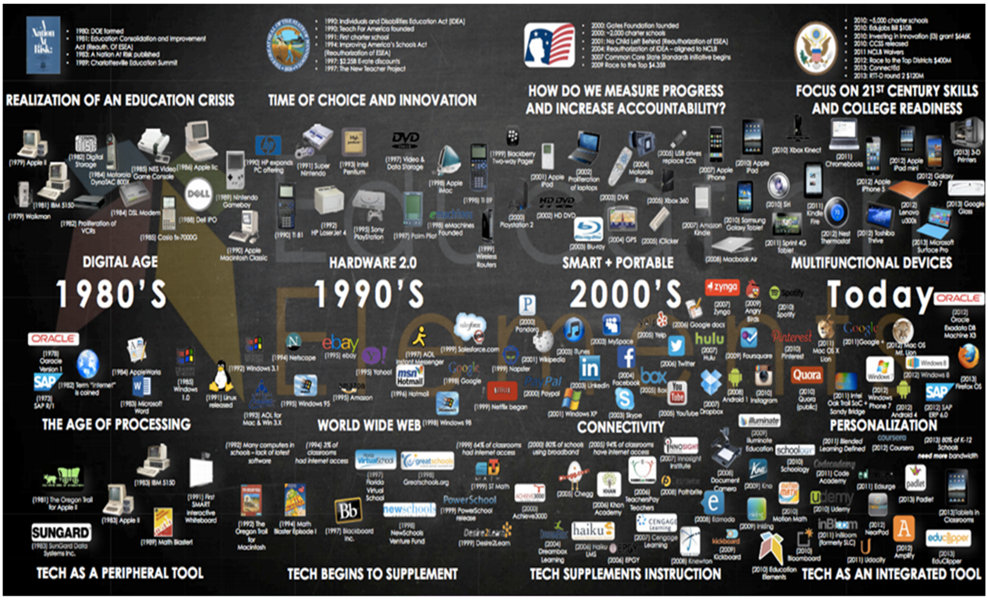


Figure no. I.1. *Infographic of the evolution of educational technologies.*

Was affected by a part of an economic factor, the costs were not easily supported by schools, and on the other side of a cultural factor, probably due to the use of technical terms and technology as synonyms, making technology perceived as a complication in educational processes.

It was still in the prospect of having a computer room and not computer science in the classroom, still limiting the use of information technology to learning a technique, learning the corpus of the rules to use an instrument for a specific purpose.

The 80s define the years of the digital age, where computers are beginning to be present even in the reality that they were not large organizations and witness the first diffusion of personal computers and the birth of the philosophy of home computers.

Even if the computers were not powerful and above all they were not cheap the release in 1981 of the IBM PC, a desk top, that followed the release in the year of APPLE II the first home computer had started a process that leads to the creation of software video writing, spreadsheets, graphics programs and games.

The availability of this software brings schools closer to the need to train also through these tools. Technologies are still an accessory of the teaching-learning process and above all they are still viewed from an instrumental point of view, learning techniques used in the world of work.

At the same time there is the phenomenon of the progressive use by the students, the students of secondary school of that period, of computers such as the **Commodor 64**, the best-selling computer in history with over 20 million units, which, although above all, was used as a “videogame”; Was a computer in all respects and had generated curiosity for a flexible use of machines that seemed reserved for science and industry.

There was a phase in which we wondered if the teaching technology was “dreaming or dreading”, to be dreamed or dreaded, but perhaps the social development that it was having indicated that technology was simply to be used for its specificity.

In this period is rooted what, from the '70s can be defined as information age with multiple tools such as television, video recorders and videotape to allow an ever-greater creation and dissemination of information.

The end of the '80s sees the development of graphical interfaces, menus, windows and icons on the one hand, and on the other side the development of the Internet and the World Wide Web.

The '90s are the era of hardware 2.0, intended as a set of tools that facilitate human-machine interaction according to a communication mode oriented to the end user, with graphical and self-explanatory interfaces.

In this we can define the digital age, the educational technologies, also with the help of the development of the Internet, began to be teaching supports, using programs to simulate processes and tools; computers support this evolution by becoming more powerful and supporting the

first use of the WEB also as a means of exchanging experiences and finding educational tools.

In the 2000s, we are witnessing the development of mobile and smart devices[2] we are in the age of interaction and the educational technologies are increasingly integrated in the learning-teaching processes (Rivoltella, 2010).

The key word of this period is connectivity that allows us to try an educational continuity between the formal, the informal and the non-formal because the spread of smartphones and tablets, and the wide production of mobile applications, make this generation of students of secondary school is constantly online, connected.

In recent years that, from a technological point of view, have seen an increasing diffusion of multiple types of multifunctional devices, we must respond to the growing demand for customization.

This allows teachers to disseminate information more efficiently, information that students of secondary school can browse, search, and explore to learn effectively; the challenge to personalization allows an effective integration of the technologies in the learning-teaching process.

I.2. Independence from devices and transversal skills

Introducing this paragraph, it is fundamental to shed light on the perspective and meaning of the concepts that are examined in this part of work, the concepts of

- **independence** from the device;
- **transversal skills / competences**.

[2] **Smart device** is an electronic device, generally connected to other devices or networks through different wireless protocols and capable of allowing interaction with other devices and working autonomously.

The concept of independence from the device relates to the digitalization of content and therefore a conceptualization plan for the structure of the contents.

There is no mention of device independence in relation to the user but relatively to the need to define a method of describing the logical structure of a document, not binding to the type of device that will carry the document.

On the one hand, this encourages the structural analysis of the contents, analyzing the documents in relation to their structure to be able to use them in different forms and on different devices.

On the one hand, this design and work approach aims to tackle the problem of digital obstruction and on the other, to exploit a side effect of the digitization of documents: the understanding of the logical structure that governs and underlies them.

The concept of skill or transversal competence means the specific characteristics that are used by individuals in reaction to an environmental stimulus.

Individual characteristics become fundamental in order to transform knowledge into behavior.

The term transversal competence is therefore used in a general sense, not in relation to a specific area, but of a skill applicable to different tasks and contexts.

Notable examples of transversal competences are diagnosis, relationship, problem solving, decision-making and communication skills.

The instances of personalization and the observation of the multiplicity of devices with which it is possible to connect and enjoy content, multimedia content and interactivity as an added value and founding feature has also addressed teaching technologies and tools related to philosophies of independence from the device, device independent, and that mobile learning is an important reference.

The focus on mobile learning and the independent device logic of educational technologies is a pragmatic choice supported by data on the diffusion of different mobile devices and network accesses.

Particularly interesting does Audiweb, which highlights the capillarity of Internet access in Italy, present the data at the IAB Forum 2014[3] (See Figure no. I.2.) and how mobile is likewise a widespread tool among users.

Audiweb Trends data say that forty million Italians between the ages of 11 and 74 can access the Internet, to be connected from anywhere and with any tool; a number that represents 84.4% of the age group considered and that shows an increase of 6.8% in the last two years. The age group allows talking about teaching technologies and current trends in relation to both traditional training and for all continuing education projects.

Among the data collected it is also important to note, in this analysis, that the mobile, smartphone and tablet, is the main means of daily connection to the network, in contrast to the use of the PC to connect, with a decrease of 7-8 % in daily use.

This rapid evolution of technology and trends in its use and methodological reflections lead educational technologies to a **BYOD** or **BYOT** design approach (**B**ring **Y**our **O**wn **D**evices), but with an interesting perspective of an approach **BYOB** (**B**ring **Y**our **O**wn **B**ehavior).

Research and experimentation in the development phase take into account the fact that, on the one hand, innovation derives from the interactivity of the tools; on the other hand, it now has the benefit of interaction and connectivity, potential which must however be transparent with respect to the device used by the student in general and of secondary school in particular.

[3] **IAB** (**I**nteractive **A**dvertising Bureau) organizes the IAB Forum one of the most important events on digital and interactive communication in Italy; the IAB Forum 2014 was held in Milan in November 2014

LA TOTAL DIGITAL AUDIENCE IN ITALIA

	TOTAL DIGITAL AUDIENCE (2+ anni)	PC (2+ anni)	MOBILE* (18 - 74 anni)	SMARTPHONE (18 - 74 anni)	TABLET (18 - 74 anni)
UNIQUE AUDIENCE - DAILY (.000)	21,153	12,932	16,404	15,023	5,164
UNIVERSE REACH - DAILY (%)	39,2%	24,0%	37,8%	34,6%	11,9%
TIME PER PERSON - DAILY (HH:MM)	2:05	1:12	1:44	1:29	1:12
UNIQUE AUDIENCE - MONTHLY (.000)	28,570	27,099	18,601	17,545	7,233
UNIVERSE REACH - MONTHLY (%)	52,9%	50,2%	42,9%	40,4%	16,7%
TIME PER PERSON - MONTHLY (HH:MM)	46:08	17:09	45:52	38:03	25:39

* Mobile = smartphone e tablet al netto delle sovrapposizioni
Fonte: Audiweb Database, dati Settembre 2014 - Audiweb powered by Nielsen

Figure no. I.2. *Digital audience data in Italy 2014 (Source: IAB Forum one of the most important events on digital and interactive communication in Italy; the IAB Forum 2014 was held in Milan in November 2014.*

BYOD or BYOT means in practice "bring your device" and is a philosophy born in the business as a policy that aimed to ensure that employees could access corporate information using their PCs, smartphones and tablets.

This policy has not only an economic impact and security policies but also in the design phase, where it is required to define tools that allow us to implement applications that can be used with the same potential in different environments, both for the operating system and for device.

The BYOD born in the company with the main purpose of cost reduction has the undoubted advantage of allowing people to continue to use a technological object that they know and use competently.

The same motivations also induce the introduction of BYOD logic in schools and training in general, because above all it allows sharing the material and maintaining a continuum between works in the classroom, at home and in any other place where data and information can be accessed.

Of course, both from a technological and methodological point of view, a BYOD approach can present pros and cons, but careful planning and structuring can certainly make the most of the advantages that BYOD brings with it.

It can be noted that today mobile devices and successful services have two characteristics in common:

- they are intuitive and quick to use,
- if you do not understand how to complete a task in a few seconds, try, download and try another application.

All this in addition to exploiting the skills of the students of secondary school makes it possible to improve the use experience in the classroom.

The most interesting perspective is this kind of experience induces BYOB, “use your behavior”, induces the use of technologies in a broader perspective and integrating the teaching-learning process in the life of the students of secondary school, which in most are constantly connected.

It is possible to exploit, in the use of educational technologies, the habit of sharing information with people in the same community as they have induced the functionality of social media, considering that collaboration is fundamental and natural in a learning context. In this perspective, BYOB presents itself as a transformation vector for educational technologies.

In support of these methods of use of educational technologies, there is also the tendency to generate APP, precisely in order to not be bound to the device of use and to decline the concept of computer application in function of a customization based on the need of 'user.

The APPs are also characterized by simplicity in order to achieve functionality and speed, in line with the logic of making the most of mobile devices but also obtaining the result of being an easily generalizable tool.

This brief definition highlights the reason for the development of educational APP or anyway dedicated to access to educational material.

These considerations on the influence of educational technologies deriving from the use of *multi-devices* and multifunctional devices can be summarized with three key words:

- **flexibility**: learning times and places can not only be classrooms and classrooms; time and space are the new architectural barriers that can impede free access to education;
- **sharing**: the society in which we live is characterized by a peer-to-peer network access to information and knowledge; the network is the communication format;
- **connectivity:** learning based on the paradigm of networks, has produced the theory of learning the advent of the digital age, known as connectivism.

Augmented reality, geolocation, mobile learning, Ubiquitous learning and IoT

The development of WEB 2.0 tools and tools that the semantic web instantiate the six key words as well is represented by the semantic cloud that traditionally schematizes it:

- Participation
- Usability
- Convergence
- modularity
- Standardization
- Design
- Economy

They promoted the development of tools and related teaching technologies based on the concept of cross-media.

The importance of the concept of cross-media lies in the fact that technically highlights the possibility of enjoying and transmitting content using different media of communication.

The passage between different devices, exploiting the physical characteristics that allow easy use (Gibson, 1950; Norman 1988) and based on the concept of affordance i.e., from a cognitive load point of view using each device based on its characteristics, for what it does best (Jenkins, 2006).

Both *multimedia* and *cross-media* become more important in the function of the concept of portability linked not only to technical problems, to interoperability between platforms and data structures, but also in terms of mobile.

There are many jobs that present data relating to technologies and their uses; interesting and to support these trends are the researches carried out annually by we are social, a socially led creative agency (***www.wearesocia.com***).

In this perspective will be described some technologies that find interesting perspectives and applications in the field of teaching technologies, then analyzing the tools that allow an effective use in teaching-learning processes.



Figure no. I.3. *Semantic cloud of WEB 2.0 (Original by Markus Angermeier) (http://www.parkwayschools.org/students/hs_ms_media_center/web_2_0_resources)*

The technologies that are analyzed are in particular:

- **Augmented Reality (AR - Augmented Reality)**: enrichment of human sensory perception through information generally manipulated and conveyed electronically, which would not be perceptible with the five senses.
- **Georeferencing**: attribution to a datum of information related to its geographical location
- **Mobile learning (m-learning)**: distance learning with the help of personal electronic mobile devices such as, for example, tablet or mobile phone,
- **Ubiquitous Learning**: can be defined as an everyday learning environment that is supported by mobile and embedded computers and wireless networks in our everyday life (Ogata et al. 2009).
- **Internet of Things** (IoT - Internet of Things): in telecommunications it is a neologism referring to the extension of the Internet to the world of concrete objects and places. Introduced by Kevin Ashton, co-founder and executive director of Auto-ID Center, during a presentation at Procter & Gamble in 1999.

Attention to these technologies is due, in addition to the intrinsic potential of use from an educational point of view, to their potential to be trans-platform, multi-device, online and implementable through network tools that require above all design skills and no specific technical and programming skills.

Once it seemed there was a clear distinction between what we thought of reality, how we told it and reality itself. Literature and theater before, cinema, radio and television then contributed not a little to overlap the worlds of thought and those of the practiced.

We could look at an object, listen to a person, attend an event and "read" all of this, and that is to increase its meaning, in a very different way according to the points of view, emotions, culture received according

to personal history. Then the frame of ideas, the imaginary screen began to present vanishing points with increasing contamination between ideas and human things. With the Net, our history has become the data that we and others can have on us. If you thought up to a few years ago, to life on the screen, recording a transfer of people and things on the Net, today life is the screen with which we interact.

The digital network, in fact, refers to the fact that each subject is part of a global reality that cannot escape, so much so that, although in different ways and intensity, everyone "increases" the reality with its more normal actions (Toschi, 2012).

An instrument and a concept, that of augmented reality that, although easily associated with recreational or commercial applications, can be found in the reflections of many scholars from the second half of the 19th century with markedly educational accents.

An instrument and a concept, that of augmented reality that, although easily associated with recreational or commercial applications, can be found in the reflections of many scholars from the second half of the 19th century with markedly educational accents.

It is not out of place to remember how Wagner is considered a musician who has transformed musical thought through his idea of "*total opera*". Total thought is thought of as a synthesis of several arts from poetic to visual arts, musical arts and dramas with the aim of making the audience immerse themselves in its theater; a total immersion that induced the widening of the boundaries of the normally perceived reality.

Even if the technologies were concentrated on virtual reality since the 90s, the concept of reality increases, where the user no longer enters a world created by software, but a process is generated that is why information that is provided by the environment with which it interacts. Integrating reality with the aid of devices, today mobile devices, which

allow connecting *information layers*[4] to the physical world with the aid of *video tracking*[5].

The use of augmented reality in educational technologies has the benefit of allowing the enrichment of sensory perception through information generated, electronically and semantically connected to the environment.

This is information would not be perceptible with the five senses; we can refer to those applications of augmented reality related to museum education, which first took advantage of the opportunities of this technology with free applications for mobile devices.

Notable examples of this technology are the APPs developed for the Museum of Modern Art (MoMA) in New York, the Prado Museum in Madrid, the London British Museum, the Louvre in Paris as well as the Uffizi Gallery and the Vatican Museums, only for mention some of the most important.

For the augmented reality, it is therefore interesting, finally, to detect the possibility of interaction with the physical environment through virtual elements, in real time, thanks to an interactive graphics system that adds information in digital format to reality, opening effective perspectives for a markedly educational use of this technology.

The diffusion, often recalled, of mobile devices allows considering also the use of georeferencing technologies that integrate well with augmented reality and with the need to allow access to information also connected to the location of the request.

---

4 The term **layer** is used in the processing of digital images to separate the different elements of an image. A layer can be exemplified as a transparent sheet to which effects or other images are applied to be arranged above or below a base image

5 The term **video trackin**g indicates the process by which an optical device can be detected through an optical device, such as a camera or a camera of a mobile device. To this optical process, it is possible to associate an algorithm that, having identified the object, can associate and display other informative objects or texts on the screen, in positions related to the object being framed.

Didactic technologies begin to take an interest in the concept of georeferencing in its specific meaning, that is, the provision of information, linking it also to the attribution to every information of data that links it to a geographical location.

Geographic dislocation is easily usable considering that all mobile devices have geolocation systems that allow identifying their position according to different techniques that may not even provide for connection to the Internet.

This technology allows a reworking of learning technology in the research process of generic information that Google applies when processing a request by a user provides results that obtains by applying both parameters for *ranking documents*[6] and data that define the user's geographical location same.

A recent example of the use of this technology is the collaboration of the University of Florida, College of Journalism and Communications, with the Yik Yak[7] platform, whose announcement is in April 2015, for the creation of personalized content *feeds*[8] for students who in the area or around the university campus.

The feed, called Swamp Juice, is used by Florida University journalism students to share news, campus events, or other interesting information for the student community, which can both assess the interest and relevance of the news, in turn, share news and events.

---

6 By ranking, ranking of merit, a document on the web means the position it occupies in a list defined through parameters and algorithms that consider different variables, which may be the number of links on the page or the average number of visits. Ranking algorithms use different parameters depending on the type of searches and documents they are dealing with.

7 The **Yik Yak** Mobile Application is a social media, distributed since 2013, which allows you to receive, create and share posts within a radius of approximately 16 kilometers around the user's location.

8 For ***feeds***, which means flow, in the field of information and information technology, a text file with information to find and access new content published on the network. A stream is used to provide users with a range of frequently updated content. Those who distribute content make feeds available and there are aggregators that allow simultaneous access to feed sets.

The dean of the College of Journalism and Communication has commented on the experience of the College of Journalism and Communications:

"We are excited to experiment with new ways to distribute relevant content for users of Yik Yak [...] This experiment is based on our mission to exploit our INC (Innovation News Center) to give new indications on innovative approaches to narration and content". (College News, URL: https://www.jou.ufl.edu/2015/04/09/college-and-yik-yak-partner-to-create-unique-customized-local-news-feed/)

The INC students currently produce over 20 articles and feeds a day, experimenting and learning journalism with the importance and power of location-based messaging, through a platform that the NIC director calls "*the modern square of the country where it is important be there, both for gathering news as well as engaging in dialogue*".

Geolocation technology well supports all the educational approaches that have in geographic-spatial positioning the characteristic of the learning environments they intend to use.

Geolocalized applications, such as teaching technologies, can support learning-inspired interventions as a model that sees learning in function of the activities carried out and in the context in which it takes place (Lave, Wenger, 1990).

An application that combines geolocation, outdoor and local education, which also combines interactions with the use of reality, is the GLOCs (Geo Localized Online Courses), is, as described by Mario Rotta like an open learning environments based on the geographical positioning of the participants and on the principle of "geolocation" where it is not the technology that filters and directs the perception of the world, but the world as such that reveals to those who can observe what it contains and the possible paths that can develop starting from that particular angle, from that point of view, from that particular place (Rotta, 2015).

An experimentation, in Italy in city of Arezzo of GLOCs, "Guardarsi attorno: Arezzo" ("*Look around: Arezzo*"), has been active

experimentally until May 31, a course that is a journey to discover 18 places in Arezzo, places that for their specificity and wealth can tell the story of the city.

With a wider view on the use of educational technologies regarding the multiplicity of mobile devices, it is important to analyze, in a synthetic way, the potentials and perspectives of mobile learning, or m-learning.

The mobile learning, made possible by the wide diffusion of mobile devices among the students, tends to the definition of didactic interventions releasing them not only from the synchrony, from the co-presence of teacher and student, but also from the time and space limits that other types of devices , such as traditional computers, however they impose.

An educational technology, that of mobile learning, which enriches the potential of fruition with the evolution supported by information technology known as *electronic learning*, *e-learning*, which in turn has enriched and enhanced distance learning, *distance learning*.

The technologies and methodologies linked to mobile learning are the subject of various experiments and the European community has given impetus to research in this field since 2000.

The growing attention, even outside the Anglo-Saxon world, to mobile learning was the first international conference on furniture in December 2014 in Bologna to deal with a new training paradigm that starts from the use of mobile communication technologies, from exploit in their ability to be capillary, continuous and multi-channel.

The lines of development and research of teaching technologies, more and more, have in mobile devices a point of reference, not from a purely technical point of view, but also methodological because we place ourselves in the perspective of structuring documents so that the use of contents is independent of the device used.

With this precise connotation, an evolution of mobile learning is developing in what is called ubiquitous learning, a logic of defining learning environments (see Figure no. I.4.) **ULE** (**U**biquitous **L**earning **E**nvironment) accessible in different contexts and situations.

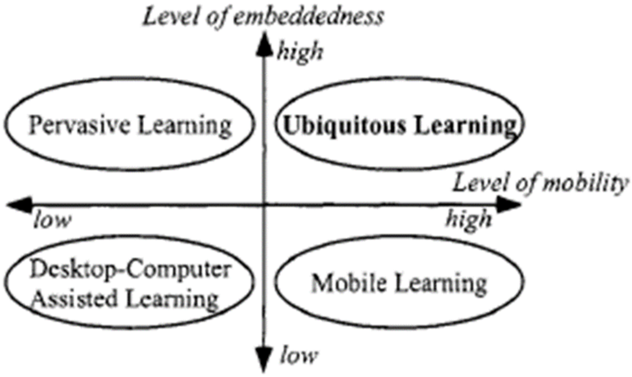


Figure no. I.4. *Learning environments (Ogata, Akamatsu and Yano: Computer Supported Ubiquitous Learning Environment for Vocabulary Learning using RFID Tags); the scheme considers the* ***level of mobility*** *(Level of mobility) and the* ***level of integration*** *(Level of embeddedness*[9]*) (of the different types of learning environments.*

Learning environments included in the reality, transparent to the user in their configuration, and with the purpose to guarantee a dynamic access to available digital resources with more dynamic and at the same time semantically defined forms, with an attention to social interaction with educational purposes.

The scenarios we are facing are evidently undergoing a strong technological and methodological evolution, but it is increasingly clear that the interconnection between the two evolutions is ever stronger; in this perspective of considerable interest the timeline that tracks conceptual changes (Park, 2011) from e-learning, to m-learning up to u-learning (see Figure no. I.5.).

Experiments and u-learning applications are in full development.

Some studies and research by JISC[10] show data that demonstrate the educational and educational effectiveness of the ULE in the specific field of training of trainers.

---

[9] With the term **embeddedness**, learning environments are defined as the rooting of social learning activity.

[10] **JISC** (**J**oint **I**nformation **S**ystems **C**ommittee) is a UK non-ministerial public body which has the role of supporting higher education and research, working in the field of information use and communication technology (ICT) for learning, teaching, research and administration.

The ULEs are also suitable for strengthening the skills of the actors through the sharing of know-how, proposing an expansion of the areas of use of the model.

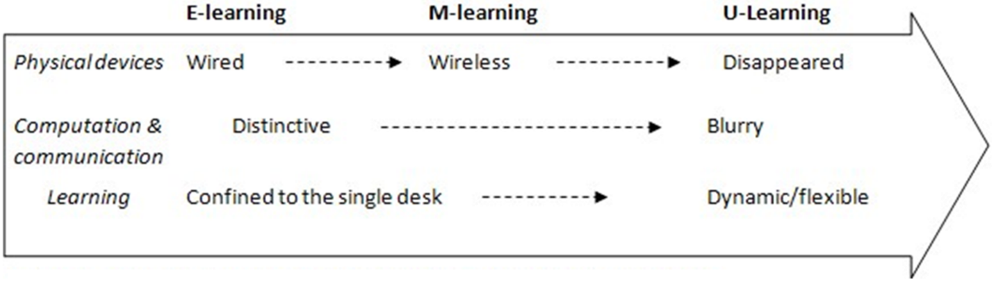


Figure no. I.5. *Development and comparison of tools, communication and learning methods in e-learning, m-learning and u-learning. (Source: Park, Y. (2011) A Pedagogical Framework for Mobile Learning: Categorizing Educational Applications of Mobile Technologies into Four Types, IRRODL, 12 (2)).*

The strengths that ubiquitous learning highlights, according to the technology to which it refers, are well summarized by Daniel Schneider[11] in *Automatic Persistent Memory Management for the Spotless[tm] Virtual Machine on the Palm Connected Organizer*[12]:

- **Persistence**: students of secondary school never lose their job unless it is deliberately deleted. Furthermore, all learning processes are recorded continuously.
- **Accessibility**: students of secondary school have access to their documents, data, or videos from anywhere. This information is provided based on their requests. Therefore, the learning in question is self-directed.
- **Immediacy**: wherever students of secondary school are, they can immediately get all the information. Thus, students can quickly solve problems. Otherwise, the student can record the questions and search for answers later.

[11] **Daniel Schneider** is an associate professor at **TECFA** (**T**raining and **L**earning **T**echnologies), a research center at the Faculty of Education and Psychology of the University of Geneva.

[12] Technical Report of Sun Microsystems, Inc. Mountain View, CA, USA ©2000

- **Interactivity**: students of secondary school can interact with experts, teachers or peers in both synchronous mode and asynchronous communication mode. Therefore, the experts are more reachable, and knowledge becomes more available.
- **Placement** of teaching activities: learning could be incorporated into our daily life. The problems encountered and the knowledge required are all represented in their natural and authentic forms.
- **Adaptability**: students of secondary school can get the right information, in the right place and with the right way.

This introduces a subsequent technological development represented by what is called **IoT** (**I**nternet **o**f **T**hings).

If we observe IoT from a point of view, purely descriptive with respect to pure technology, we can describe it as a scenario in which all the "things" that make up reality, including individuals, have unique identifiers with the possibility of transferring data from entity to entity without requiring a human-to-human or man-machine interaction.

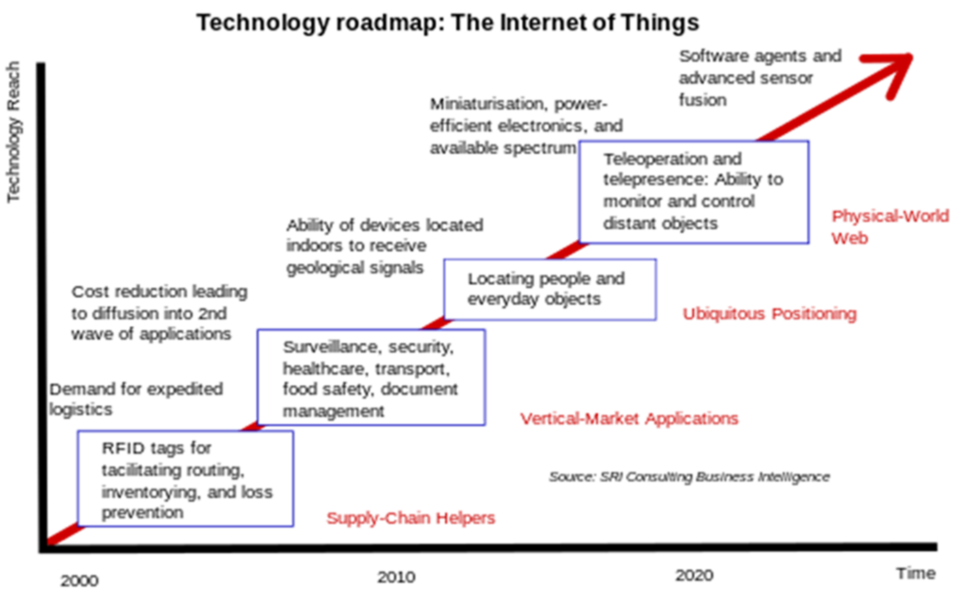


Figure no. I.6. *Trace of the technological development of IoT (SRI Consulting Business Intelligence / National Intelligence Council - Appendix F of Disruptive Technologies Global Trends 2025 page 1).*

An easily conceivable scenario with the widespread use of mobile devices, wireless technologies and the Internet.

However, the Internet of Things is a perspective view and the hypothesized path of development (see Figure no. I.6.) shows how educational technologies can benefit not only as an economy of scale in the distribution of content but as a background and integration of all those mobile technologies, u-learning and m-learning

The investment, both in terms of technological and methodological development, which is taking place around the Internet of Things, is also a function of the fact According to Gartner[13] estimates, in 2020 there will be 26 billion objects connected globally and ABI Research[14] estimates that will be more than 30 billion.

From a point of view then of the data that the network will make available, ABI Research has always calculated that in 2014, the data acquired through IoT devices have exceeded 200 Exabyte's and it is expected that in 2020 we will talk about 1.6 zettabyte, about 180 million sometimes the documents kept in the Washington Library of Congress.

These data cannot be neutral information for those involved in training and education. In terms of architectural development, the Internet of objects is developing a paradigm shift: from *cloud computing*[15] to *edge computing*[16], which is important from the point of view of the use of information as well as information.

---

[13] Gartner Inc. is a multinational company for strategic consulting, research and analysis in the field of Information Technology, among the most important in the world.

[14] ABI Research is a company that deals with technology market intelligence and collects data on technologies and market trends.

[15] *Cloud computing* is a term that identifies a paradigm that in computer science defines a mode of supply, storage and processing of resources or the transmission of data, characterized by the availability required, on the network, by a set of pre-existing and configurable resources.

[16] *Edge computing* is a logic that transfers the localization of information applications, data and services from the central nodes of the network to the logical extremes to allow the analysis and generation of knowledge that is generated at the source of the data.

Before painting a picture of what have been identified as trends for teaching technologies and some tools that allow a simple planning, implementation and use in an educational environment, it seems appropriate to reflect.

Reflect on the use of educational technologies from an image of a group of teenagers in a room of the Rijksmuseum in Amsterdam; in front of Rembrandt's painting “The Night Watch” (see Figure no. I.7.).

In front of this image, it is evident that the first reaction is to consider technology as a strong distractor if not an obstacle to a correct relationship with reality.

Here we do not intend to make a sociological or psychological analysis but starting from the observation that technology and, as in the case of the Amsterdam museum, young people use mobile technology, it can be said, “that it is a privileged channel of communication that educational technologies cannot ignore”.

The process that technologies must then implement is to use the devices to raise the eyes of the children to the picture, a framework that can be used with interactive technologies interactively analyzed, a virtuous cycle that connects the technologies, the abilities of the children in the 'use them, interactivity and socialization of content.

The contribution that these technologies can make to the enhancement of learning processes, according to their technical and functional characteristics, requires a broader discussion than is possible in this work, which deals with providing a framework that is as much organic as possible, what are the technological tools and how they are now integrated into the design of learning-teaching processes.

However, in an indicative way it should be noted that technologies, mobile technologies, are a tool that largely permeates the actions of children's lives, in an era in which participatory logic, which

has as a macro example, Web 2.0, see the classes, be a *knowledge building community*.



Figure no. I.7. *A group of teenagers, most likely schoolgirls, on a trip, in a room at the Rijksmuseum in Amsterdam in front of "The Night Watch" by Rembrandt. Tweet by Gary Pikovsky (Source ilpost.it).*

This consideration highlights how the technologies examined are an excellent tool for sharing and interacting with content, both from a constructivist point of view and a gradual reduction of the *digital divid*e that has become the cause of a *knowledge divide*.

I.3. Technological trends and online tools

The changes to which technology is subject, however, make it difficult to identify precise lines according to which the actors of the educational world are moving and with them the teaching technologies.

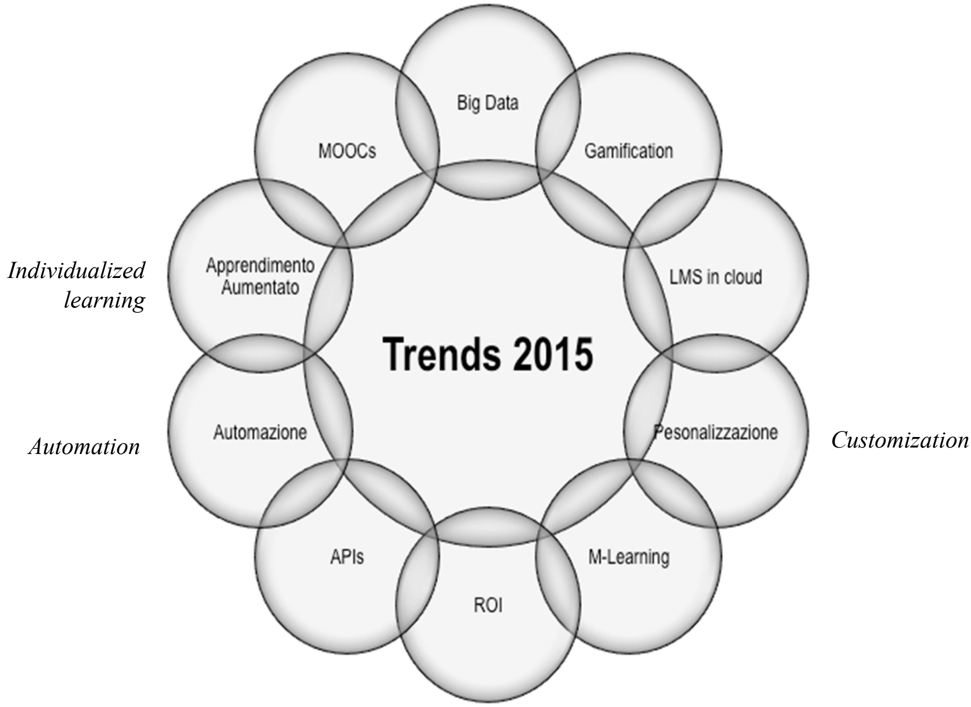


Figure no. I.8. *Schematization of the graphic presentation presented in Smith's 2015 trends article (www.edtechmagazine.com/higher/article/2014/12/10-online-learning-trends-watch-2015-infographic-0).*

Each application goes from being innovative to being obsolete in a short period.

However, it is still interesting, starting from an infographic[17] (see Figure no. I.8.) presented in an article by Frank Smith published in the

[17] The trend infographics and the article are available at: www.edtechmagazine.com/higher/article/2014/12/10-online-learning-trends-watch-2015-infographic-0

on-line magazine **EdTech**[18] and starting from the reflections developed at the **EDUCAUSE**[19] **2014** conference (held in Orlando in October 2014).

This reflection is based on the analysis of some reported trends that seem to be particularly interesting as a backbone for the development of educational technologies.

Trends and technologies seem in any case to gravitate on two fundamental concepts the number and the interconnection; a number that sees technologies dealing with large masses of data, large numbers of users and **large numbers** of different devices and an **interconnection** that allows people to constantly interact with other people, with information and tools.

In this dimension, we must read the first of the emerging trends in educational technologies that is to refer more and more frequently to big data.

The number of people, tools and technologies that use and share data are constantly increasing, generating a considerable amount of data and information that no traditional methodology could handle.

This scenario, traditionally defined as e-learning, begins to take advantage of the big data philosophy, a term that is used to identify data collections characterized by large volumes but above all by the speed of data generation and the great variety of format of the same, due to the fact that they come from a wide range of different sources (De Mauro, Greco, Grimaldi, 2015).

Big data, characterized originally by volume, speed and variety, have integrated with their development the characteristics of variability

---

[18] EdTech, (site: www.edtechmagazine.com) is an online magazine divided into two technology magazines, dedicated to IT professionals (Information Technology), with two focuses: schools K-12 schools and educational institutions higher.

[19] EDUCAUSE is an American non-profit association that gathers more than 1.8000 tar Universities and Colleges, and 300 companies, and aims to promote and support analysis, community building, professional development and knowledge creation in support of the transformational role that the IT (Information Technology) can play in the field of higher education (site: www.educause.edu).

and complexity, which respectively identify the possibility of inconsistency of data and complexity of data management in relation to their remarkable quantitative increase.

For big data in addition to the change in approach to the analysis of information, it is necessary to use new analytical technologies among which it is interesting to remember, among those listed in a report of the McKinsey Global Institute of 2011, *machine learning*.

Machine learning or machine learning is one of the areas of interest of artificial intelligence that deals with defining systems of analysis based on data observation paradigms to extract new knowledge.

Essentially machine learning, or machine learning, has the goal of being able to define tools that automatically recognize complex models to make intelligent decisions based on the data obtained, as Mitchell says: "*a program learns from a certain experience and if: respecting a class of T tasks, with a performance measure P, the P performance measured in performing the task T is improved by the experience E*" (Mitchell, 1997).

Big data can be used by educational technologies to understand learning processes and help understand how learning processes develop.

The models of analysis of big data, moreover, can help to define which learning models follow the groups of students are formed, for example how they navigate among the materials and share comments and information.

These large-scale analytical tools also allow for course customization processes, allowing you to detect what behavioral differences there are in certain sets of students of secondary school.

Another interesting trend that is addressing educational technologies is gamification, which could be considered in a **BYOB** (**B**ring **Y**our **O**wn **B**ehavior) paradigm that elements of game design in non-gambling contexts.

We try to exploit the fact that for people the game is a voluntary action and done with pleasure.

The gamification is characterized by different elements that are inserted in the didactic paths to exploit the dynamics and mechanics of the game to induce active and measurable behaviors.

About their use and their effect, five basic elements and four modalities can be identified in the gamification that induce students' involvement in the learning process.

The basic elements, which various teaching technologies are used, are:

- **points**, which allow a measure of the level of completion of a path by a user and eventually allows comparison between two users;
- **badges**, indicators of the level reached or of the skills acquired by a user; there are projects of digital badges, such as Mozilla Open Badges (OBI - Open Badge Infrastructure) to recognize skills and share them on different digital platforms;
- **levels** that encourage users to discover new information and get new badges;
- **rankings** to divide users into ranks;
- **challenges** to encourage involvement through the assignment of specific tasks to be completed.
- The four modalities that lead to involvement in the learning process can be described as:
- **acceleration** *of feedback times*, such as evaluations of a task;
- **clear** definition of tasks and objectives;
- compelling **narratives**;
- challenging but achievable **tasks**.

In short, the interest of gamification applied to educational technologies together with the BYOB paradigm, which can be traced back, lies in the fact that people want to share their successes and considerations and at the same time love competition.

Considering the potential of the technologies highlighted also using big data a trend in the development of teaching technologies is the

creation of **personalized learning** processes, a trait characterized by pedagogy.

There is a clear perception that a goal that teaching technologies can help to pursue is precisely personalized learning that can be instanced through the design and "*automatic*" implementation of curricula and learning environments in which students find their way to pursue their aspirations and their training needs.

Educational technologies support the goal of personalized learning through tools that allow:

- **adapt** the pace of the learning process to the student;
- **adapt** the learning approach to the student;
- **allow** the student to choose the learning path;
- **adapt** to the student the format of presentation of contents, from text to audio to video;
- **leverage** on the skills and interests of the student.

In correlation with the trend of generating tools for personalized learning and having as a potential target a high number of students, as also seen in the premises of this work, mobile learning, m-Learning, is an emerging teaching technology.

In particular, mobile learning is supported by the continuous increase in mobile devices, which is increasingly the medium through which to distribute educational materials and has as its strengths:

- **easy access**: you can access content from anywhere and when you need it;
- **contextual learning**: use of geo-referencing technologies and simple tools for interaction with the environment such as **QR**[20].

[20] **QR codes**, QR Code (**Q**uick **R**esponse **C**ode), are two-dimensional square matrix barcodes aimed at storing information accessible from mobile devices, such as tablets and smartphones. A single QR cryptogram can contain up to 7,098 numeric characters or 4,296 alphanumeric characters that describe the information that can be a text such as a web address.

However, this investment in terms of educational technology is not an economy for a world such as education and training for which it is important to note that the **RoI** (**R**eturn **o**f **I**nvestment) calculation of e-learning in general is also done.

In this context, if we consider the costs of hardware and software infrastructures and the creation of interactive material and benefit the economies of scale of decreasing logistic costs, such as travel and the possible re-use of materials for all the training paths that require it.

The ROI of teaching technologies is certainly to be taken into consideration, but their flexibility and effectiveness in distribution and continuous and simple access to information certainly generate a positive balance.

In this positive balance, an important contribution is given by **automation**, i.e. the implementation of tools that allow the automated creation of courses and contents from archives of documents in different formats.

This in addition to a benefit in terms of time and production costs also allows an increase in the quantity and quality of the courses that can be offered.

Research in this field has produced tools that, using particularly complex algorithms, generate tests and exercises correlating them to the materials supplied or personalizing the path of each individual student based on the navigation of the contents and the results of the evaluation tests.

In the production of materials and technologies that instigate the paradigm of personalized and contextual learning, an emerging role, in a society that is increasingly visual and interactive, is covered by **augmented learning**.

The trend that characterizes educational technologies is a method that can be defined as an on-demand learning in which the environment adapts to the student.

This adaptation takes place by exploiting augmented reality, mobile devices, QR and geolocation, further correlating the emerging educational technologies to integrate learning in daily activities.

The development trend of augmented learning is also pragmatically justified by the fact that market surveys have shown that if in 2013 there were 60 million users of augmented reality in the world, in 2018 it is expected that there will be 200 million.

In a partially evident way, a scenario that characterizes some of the educational technologies and related trends of use is the awareness that users, students and information are in large quantities and in continuous increase.

From this perspective, since 2011 there has been a growing use of **MOOC***s* (**M**assive **O**pen **O**nline **C**ourses), courses that aim to be courses for large numbers of users who can enjoy large numbers of information online.

The growing diffusion and attention to this teaching technology is evidenced by the birth and growth of MOOC platforms that affect both the university world and the business world. Important and wide-ranging examples for the implementation and distribution of MOOC are the American platforms **Coursera**[21] and **edX**[22], as well as the new Italian platform **EDUOPEN**[23], which is being tested, the result of the methodological and technological collaboration of eight Italian universities.

---

[21] **Coursera** is an American company that operates in the field of educational technology, founded by Stanford University Information Science teachers. The Coursera platform provides MOOC and in 2014, the platform involved a hundred universities and higher education institutions from around the world.

[22] **edX** is a project of MIT (Massachusetts Institute of Technology) and Harvard University. MOOCs from MITx, HarvardX, BerkeleyX, UTx and many other universities are available on the edX platform.

[23] EDUOPEN è un progetto sostenuto dal MIUR (Ministero dell'Istruzione, dell'Università e della Ricerca) che tra l'altro ha implementato una piattaforma di erogazione di corsi MOOC. La rete di promotori del progetto è formata da: Politecnico di Bari, Università di Bari, Università di Foggia, Università di Ferrara, Università di Genoa, Università di Modena and Reggio Emilia, Università di Parma con il supporto tecnico di CINECA e Moodlerooms.

Customization of learning paths, mobile learning, big data and gamification together with other trends in educational technology development, such as MOOCs, seemed to have diverted attention from the **LMS** (**L**earning **M**anagement **S**ystem) but the use of this tool is in continuous increase with a tendency to become **cloud-based LMS**.

In this way, also the LMS respond to the needs of scalability, delocalized access and management of large numbers of students and courses together with the personalization of the path.

The tendency to still use LMS effectively is also evidenced by the over 20 cloud-based LMS reviewed, to be limited to the most important such as ***TalentsLMS*** or Joule LMS developed by **MoodleRooms**.

Many others could be the technologies analyzed and many the software that implement them, but as well as the lines of development that have been taken into consideration, this wants to be a framework for a first systematic analysis of the world of educational technologies.

I.4. Reflection on the path of integration of technologies in teaching

Above all if we talk about technologies we can say "conclusion is an illusion", the conclusions are an illusion because the dynamism and fluidity of the technologies and with them the educational technologies allow only to make a reflection and express preferences with respect to future developments.

At the end of this analysis of the educational technologies in terms of tools, characteristics and prospects of development and use by way of example, an experience has been described briefly for two years in an IT course for a degree course in Science and Technologies of Cultural Heritage, then with students without technological skills.

This experimentation aims to define models for the integration of tools and information and multimedia technologies in classroom

teaching, both as an exercise activity and as an integration to the study material and teaching in the presence.

The road that has been undertaken and is gradually being pursued is that of an action research; precisely because the need is felt to give an answer to the difficulty of making classroom lessons increasingly effective and the request to increasingly integrate them technologies that represent an effective way for young people to learn.

The choice of the action research methodology is motivated by the fact that a small-scale intervention was made, and one wanted to be able to take a careful examination of the effects of the intervention itself (Cohen, Manion, Morrison, 2000).

The action that was taken was in the context of the teaching that takes place with the traditional classroom lectures, some didactic technologies were integrated in order to train them for use and to use them for didactic purposes.

An editing tool was used for a collaborative construction of a wiki, related to the topics of the course, but above all an augmented learning experience.

On the one hand, augmented reality was used to design and implement a visit to the botanical garden of the University of Ferrara both from the point of view of the material and the interaction process.

This allowed us to experiment with the augmented reality linked to paper handouts that were distributed but which could be interacted through mobile devices to be integrated with films that animated the illustrations of the lecture but also to generate together with the students the didactic path to be used by other students.

The first results were particularly encouraging because a dialogue with the students, done before the exams, showed their interest in this type of didactic intervention both for the benefit that hyper-textuality and interactivity give to the didactic materials you know for learning new skills not related to the disciplinary area.

In particular, the comments of the students have shown how they perceived a more conscious use of the use of technologies also in relation to the learning of their use as producers of content, as prosumer.

This limited experimentation, however, that the Se@ (Center of Technologies for Communication, Innovation and Distance Didactics of the University of Ferrara) is systematizing from a pedagogical point of view for its systematization in other courses, has highlighted the teaching effectiveness of the integration of this technology and therefore of the augmented learning and the real added value of the use by the students of their own devices with a view to BYOD and BYOB.

The results obtained in this experience make it reasonable to imagine the gradual experimentation of the main teaching technologies within formal training paths.

Technology cannot be ignored, even more so by those involved in training, and called to use all the methods and tools that enable effective learning.

About the current situation of training in Italy, critical points become the need for specific professional figures to support training in the medium of reference technologies. I

It should also be a critical point the training of teachers and teachers not only in the use of technology but also in the definition of didactic strategies integrated with the technologies.

Finally, yet importantly the objective difficulty must be considered, linked to an inadequate training of teachers and trainers, to the design and implementation of digital material for learning, material that exploits the uniqueness of digital interaction.

In any case, the development and use of teaching technologies to support learning are essential for the educational projects that we want to develop with the awareness that we are facing not a revolution but a natural, relevant and constant evolution.

CHAPTER II.
Technology as Resources and Risk Factor in Educational Processes

The first reflection arises from the need to reflect, in a global sense, on the training practices acted out by training technologies and on the reference epistemic framework for pedagogical studies.

It becomes interesting and effective to refer to a context of hermeneutics in order to tackle, albeit to some extent, the problem through a methodology of analysis and the relative epistemic background. The methodology here is understood here as a normative epistemology and not an ethic.

From these considerations, the attempt to clarify the relationship between epistemic values and ethical values, against the background of a need for educational concreteness. We will endeavor to arrive at a proposal that seeks, on the one hand, to reflect critically on the epistemological background, as well as on the widespread circulation of paradigms and on pedagogical normativity, which underpin educational practices acted out through new technologies. Our attention will be directed primarily to adults who live in socio-cultural or at risk of marginalization.

In this reflection and analysis, we want to show how the theories of educational concreteness work theories and models of which both teachers and re-searchers are not always aware of and which condition their educational activity.

Finally, we will elaborate proposals for an effective and conscientious use of the new educational environment born with the new communication technologies.

II.1. Introduction to the problem

The new techno-logical culture is changing the basic language, directing it more and more towards speed, interaction, sharing. As often happens, also due to the speed of the changes underway, this process is not accompanied by an awareness of the type of thought that the new languages convey or the type of knowledge they contribute to building.

To the cognitive approach of the logical, linear, sequential, structured, organizational and abstract type, they are gradually replacing reticular logics linked to the codes of the hypertext.

This difficulty of deep understanding mainly affects individuals at risk of socio-cultural marginality or, in general, more fragile.

To a greater availability of informative sources, it meets a substantial difficulty in choosing information, to orientate itself in the sea of stimulus, to govern the multimedia world with its many suggestions.

In short, simple computer literacy is not enough to build those digital skills that are the basis for effective knowledge.

Our daily life is dominated by the times and the spaces of technology. Our rationality follows more and more “technical” logics (Broers, 2009). Technology is introducing epochal changes, in personal relationships, in social dynamics both in the processes of identity building and, finally, in the mechanisms of thought processing.

The consequence is that it helped to forge anthropology and therefore the mentality of our young people on the value of operational effectiveness (Queraltò, 2008).

The thing has obvious consequences on cognitive styles and on the processes of knowledge construction.

This means that the meaning attributed to learning and, in general, to knowledge, depends on the satisfaction of needs and desires that are increasingly bound to the concreteness and immediacy of the results.

Tékhne, in fact, means "*art-knowledge in action*": concrete knowledge, which tends to do more than to know itself as an end in itself.

It is a dynamic and pragmatic operational make-know. Furthermore, the techno-logics of training draw on a vocabulary that smoothest its social use and in doing so, conditions behavior, imagination, education.

Today the distance between the knowledge that characterizes the generations has become increasingly broad, with obvious problems of communication and loneliness for both parties.

In the face of these problems, it is necessary to study the reasons for the fascination that new media exert on young people and adults, on the other hand we find it useful to try to catch those elements on which to leverage to enhance the motivation to learn, especially in those most exposed to the risk of socio-cultural marginalization.

These swirling changes affect the so-called "digital immigrants" in the adult world, above all the most fragile subjects, those at risk of socio-cultural marginality.

In the face of a difficult computerization by adults, we can use modular formative itineraries that allow the sharing of paths and methodologies.

In this regard, the MOOCs can represent a fundamental resource, a sort of new learning environment, which however needs to clarify some epistemological premises.

Finally, it is motivating adult's access to a system thinking; thinking that allows a more conscious use of new communication technologies.

Finally, we consider it opportune to make some basic clarifications. We are convinced that Knowledge, all Knowledge, requires a preparation of an epistemological nature because it refers, not so much to the reception of information, as to its elaboration. Knowing a phenomenon means understanding it, having a clear awareness of it, and being aware of itself, in relation to the problems posed by that phenomenon.

Knowledge is content and method, as it is phenomenal, that is, deals with objects, and processual, because it also concerns methods, strategies and tactics. It is, at the same time, the "*how*" and the "*thing*", because it is the phenomenon and movement of its own construction. Knowing a phenomenon means understanding it, having a clear awareness of it, and being self-conscious in relation to the problems posed by that phenomenon.

Knowledge is content and method, inasmuch as it is phenomenal, that is, it deals with objects, and processes it, because it also concerns methods, strategies and tactics. It is, at the same time, the "how" and the "*thing*", because it is the phenomenon and movement of its own construction.

II.2. Technological humus (background – substrate)

Why does multimedia attract us and how can we use its persuasive capacities for educational and / or emancipatory purposes?

One reason for the strong attraction that new media exert is to be found on the one reason for the strong attraction that new media exert is to be found on the one hand in the high degree of familiarity they have acquired and on the other in the playful-communicative dimension that they have often experienced. In short, the new technologies exert an important role in children's imaginations; they focus on their protagonist

in the processes of knowledge construction. All this has a secondary function on the motivation to learn and experiment through the computer.

The playful element of knowing, it is deep triggering with the structures of the imaginary, the evocative dimension, and finally the sense of adventure and discovery are some of the factors that explain the interest that the use of computers raises in young people.

Learning, and more generally knowledge, cannot ignore the ability to refer to evoke or enrich the icons of a fantasy that has settled in the experiences of each one.

We are inside a symbolization of reality with a high degree of connaturally, as is evident above all in the educational videos they use, on an interactive and learning scheme.

The means and conditions with which we face the world in its ineludible concreteness, are determined by the knowledge we have of the world and therefore of ourselves, as Socrates[1] teaches us, that we are in the world.

Therefore, knowledge immediately manifests its practical implications: we must know what questions to ask ourselves to face problems effectively, to make the right decisions, to choose, among the many options that experience puts us, with full knowledge of the facts.

Knowing a phenomenon means understanding it, having a clear awareness of it, and being aware of itself, in relation to the problems posed by that phenomenon.

For this reason, knowledge is content and method, evidence and model, because it is phenomenal, that is, deals with objects, and is procedural, because it also concerns methods, strategies and tactics.

For this reason, an economic recipe book cannot exhaust its tools.

---

[1] The knowledge evoked by the Delphic prescription implies the need to investigate the bottom of oneself to put to God only the essential questions, those that have an existential weight and a deep sense.

In fact, remembered Bateson (1976), it is precisely our implicit epistemology, that is, the idea that we have of knowledge and of ourselves to solicit and guide these questions.

For this reason, it is essential to know our knowledge, which is a way to start getting to know the world and ourselves.

The reflections that we present here obviously have an epistemological character and tend to clarify the implicit formative implications not only in the technological products used in the school, but also in their identity and hermeneutical function.

The conceptual nodes on which the educational theory is based on a conception of language as an inescapable form of interpretation and understanding and therefore as a transformative environment; and the subject, understood as interpreting and formed while transforming its heuristic field and, with it, the world.

This orientated function of knowledge, because it aims at critical exercise, induces autonomous behaviors, that is, free.

Another conceptual knot of wide reference in our educational reflection concerns a concept of knowledge that is substantiated by a meta-dimension, that is, which always implies the "knowledge of knowledge" (Morin, 2007).

We believe that technology does not exhaust its nature in its simple application and that educational experimentation on new educational technologies should not be resolved in their application.

We believe it is important to clarify the definition that seems most appropriate to understand, together with its structure, the evolutionary paths, the vision of the world it carries.

The concept of technology to which we think, while we use the artefacts, organizes not only the intellectual strategies we adopt in the learning-teaching processes, but also the educational procedures and practices. In this sense, the organizational and operational structure of the technologies can be conceived as a kind of grammar, that is, a

linguistic expression, because its design is a reasoned composition of tools, procedures and purposes.

Understanding its logical-grammatical architecture means being able to understand its semantics.

Such as? Identifying the constructive hierarchy of educational choices, evidences, tools, theories and values that consistently link its guiding principle to educational purposes.

In fact, a training (Gramigna, 2009), which aims instrumentally to technical and circumstantial learning, risks precipitating subjects in that fluctuating disorientation between enthusiasm and pessimism that only confusion can generate.

For example, the illusion may arise that the knowledge is exhausted, in the ability to recognize the right icon to click, or to remember the successive movements to be performed regardless of their theorization, that is, from their triggering within a clear metacognitive dimension.

On the other hand, if we place ourselves in the perspective of understanding the grammaticism underlying these movements, the strategies, and the subsequent symbolizations, then it is easier to understand how all this has interesting consequences on the reflection on the idea that we have developed .

We believe that one of the purposes of computer literacy initiated in many institutions may be this.

Consequently, our goal here is to bring to the surface the speculative canvas that can serve to clarify the processes through which we can build a knowledge of any kind. In this, we must be clear that the levels and procedures of its construction are conditioned by opinions, which are often only partly aware.

Studying these dynamics can help us to understand the processes through which we reach “that” knowledge of ourselves that can help us “to know knowledge”.

In fact, all learning is closely connected in a dialectical relationship to one of our personal epistemologies of knowledge.

The acquisition of knowledge can be fostered or hindered by the ability to recognize information and processes as meaningful on the cognitive level and, if oriented in an educational sense, can help the young person to develop new cognitive maps, and therefore to multiply the possibilities and strategies for solving problems.

It is a hermeneutical pedagogy aimed first to understand the educational phenomena linked to the educational environment of the educational technologies and then to explain them.

An education that aims at the construction of the orientations, the keys of reading, of the reference points that help us to interpret the present and to face its risks with knowledge of the cause. Among these, we report:

- Simplified vision of knowledge reduced to accumulation and fast consumption of information;
- New forms of cyber-bullying;
- Individualism of virtual relationships;
- Addiction;
- Difficulty in "getting oriented" in the virtual world.

How can we represent and explain the Knowledge in this new context of meanings?

- Processes of construction, organization, dissemination and transformation of knowledge;
- Methods, contexts of meaning and conditions of their construction;
- Conditions, in turn, pose to us the problem of verifiability of such constructions (for example, when and to what degree knowledge possesses criteria of truth, certainty and efficacy?)[2];

[2] One of the most important reflections on this subject is the Platonic Theory of Justification, which poses the problem of the conditions necessary for a knowledge to be true; See Plato, Teeteto, in All the writings, edited by G. Reale, Milan, Bompiani, 2000.

- Choosing the information that experience suggests, their interpretation and their location within our cognitive system;
- Relationship of these processes with our cognitive self, that is, with the cognitive and non-cognitive perception that we have both our cognitive field and our potential for acquisition, elaboration, invention;
- Tools to check the fundamentals of the various sciences: specific language, field of study and application, peculiarity of contents, method, procedures, theoretical background, consequentiality, verification, tools and coherence of meaning and procedural relations which interconnect with each other;
- Transversely and epistemological contaminations between different disciplinary areas: transfer of metaphors, use of narrative segments from other sectors, methodological ideas. In short: intercultural scientific expertise. We mean by competence, a basic knowledge that activates a series of acquisitions and, therefore, has a metacognition value. The social image of knowledge as an "encyclopedia" has been replaced by that of the "context". The first implied a recognition and accumulated behavior for sectors, while the second one emphasizes the heuristic and strategic function of each theory, as well as the metacognitive sense of procedures, codes, approaches. In this second perspective, which is ours, the pluralism of visual points, languages, and theoretical constructs is fundamental. A consequence of this new way of knowing knowledge is that many conceptualizations come to disciplinary domains or to areas of experimental research as-say different from those in which they are germinated. For this reason, it is important to know the dynamic semantics of knowledge, that is, to know its processes and mechanisms, to be able to build "other" knowledge and transfer skills from different spheres and times.

II.3. Description of the problem: instructing knowledge and educational experience

The knowledge that our society claims, today more than ever, is oriented towards the ideal of a science that is also technology because it is produced and produced, and because technology makes its criterion of value. It is an instrumental and concrete knowledge, it requires a hyper-specialized knowledge, and, inevitably, fragmented, pragmatic and in some ways anti-holistic.

In addition, it is in this sense that European and US policies (Margiotta, 1997) have been oriented by the Lisbon Agenda onwards.

However, what do we mean by knowledge? In our training proposal, knowledge is a conceptual entity of a procedural and relational nature.

It is a synergistic system of dynamics that has unity and physiognomy determined by its own movement.

So, what role do train technologies play in the processes of constructing knowledge and educational experience? What is the relationship between the school practices and the epistemologies that underlie them?

Technology is not just a reflection on technology, it is, first of all, a hermeneutics, because it represents a sort of total matrix, not only in the criteria of judgment and therefore of value of the social, but also in the processes of determination of identities, be they collective, as is the case of communities, or individuals.

Here, too, it is opportune to specify by value, we mean a judgment criterion which, in turn, is a model of relationship and which traces a path of signification.

The technologies of formation convey a vision of the world that is immanent to the technical artifact, as well as the strategies they activate.

The metacognitive tension that animates the processes of optimization of teaching through new technologies has an ideological dimension in the sense that it proposes a way of seeing things.

The technological artefact, which is an essential condition of science, reflects its models on knowledge and school.

Thus, the relationship between educational fact and theory immediately appears as a transformative process that involves the two poles of the question, which are never immobile or equal to themselves.

Pragmatism, in fact, is the criterion of value of the procedural rules that the technique applied to training employs because it uses norm-pragmatic formulas.

This pragmatic nature is implicit in “technical” rationality, which, in turn, is the anthropological figure of our students (Living-stone, 2010). For the digital natives, the “what's needed” is not at all implicit in the “what it is” and certainly comes first.

For us, on the other hand, knowing was tantamount to maturing a sense of coherence and clarity about a phenomenon-its usefulness was contained in its own semantics, but it did not substitute itself for it.

It is now easy to deduce from this that the educational side of technique leads to an empirical experience and underlies an epistemological experience that is, referring to models that are rarely explicit and conscious for those who benefit from it.

For this reason, we are convinced that technology designs a hierarchy of values that must be clarified, so that we can orient ourselves with critical competence, that is, with knowledge of the facts.

Hence, the need to form an epistemological formation aimed at the construction of a competent criticality that can confront the hybrid character of current science and technology.

This is our insistent proposal. Knowledge pertains to the semantic domain of the contents of knowledge, but also has a meta-cognitive tension that refers to cognitive processes (Margiotta, 2007).

Regarding training technologies and their use in schools, they represent both a method and a technique, due to the metacognitive tension of the strategies that they activate. By educational method, we mean, in fact, a coherent set of procedures and strategies governed by norms that, in turn, are governed by principles. It is therefore a conceptual system.

By procedure, however, we refer to a quality that uses both conceptual tools, or execution models, and material supports, properly technical, as is, for example, the program of the PC.

Normally, from studies of epistemology, understood as a science that studies the formal structure of scientific knowledge, we tend to exclude the contents of the discipline we are studying, which, in our specific form, is formation.

We believe instead that, in the case of the application of technologics to education, the disciplinary or, more culturally, contents are intimately connected to the pragmatic, not abstractly and differently formal logic of the technique.

This logic, which is characterized by its concreteness, concerns a cognitive approach; which has obvious consequences on the training plan.

In short, we argue that the content conveyed by a learning teaching that uses technologies ends up by expressing a pragmatic tension within itself.

By becoming more, essential and focused in relation to the "transmissivity" ends that appear more clearly and more clearly delimited.

The procedure, in short, pertains to the method of learning and teaching, that is, of construction and transformation of scholastic knowledge, thus realizing the mutual dependence between method and technique.

This is because the technique preserves in its artifacts a trace of the model as well as the method.

Both must be identified through a work of epistemological awareness.

The knowledge built with new technologies, immediately presents praxis-symbolic, concrete and abstract, because the technique is a form of thought that, in school must arrive at a formative strategy and an educational technique.

Otherwise, it is sterile technicality. In fact, the technique is a construction of knowledge, both from the symbiotic point of view and from the metallization point of view, and finally from the technological point of view of the invention.

It is procedure and product. It is construction and construction, object and symbol.

Consequently, the conceptual separation between object, cultural symbol and its metallization must have, in our opinion, only a transitory character, useful, in fact, to clarify the terms of the question.

In addition, it is for this reason that, in relation to a productive use of training technologies, we think that the forma mentis to educate must contemplate both the procedural and the finalistic aspects.

The scientific rigor of educational knowledge emerges, in the clear awareness of the epistemological matrices employed, by a continuous interrogation between theories and facts, with the aim of developing concrete proposals that address and solve the problems raised by the formative emergencies of the contemporary world.

Pedagogical research, in this sense, is scientific, when it is rigorous in the coherence between objectives, tools, methods and languages, and is useful when it produces technological objects but also theoretical ones that improve our schools; when it helps to build strategies that solve problems.

In short, the study of knowledge is a practical, useful and operative science, because it allows us to reach ends whose concreteness is tangible, often, beyond its immediate “contingencies”.

However, we also need a self-aware science and technology, of the epistemic, economic, cultural mechanisms that they activate, and of an ethic that goes well beyond the professional and procedural deontology of so much contemporary research.

Finally, in the light of this omnivorous pragmatism, let us clarify what knowledge is used for.

Knowledge shapes us, in the sense that it builds and perfects our skills, weaves the narrative plot of the autobiographical self; it greatly conditions the existential scenarios:

- Knowledge helps us to interpret the world because it provides us with tools for reading, orientation and understanding;
- So, it intervenes in the problem-solving process;
- In this sphere of ideas, we can deduce that knowledge helps us not only to express an ethical option, first, in making us aware that there are different options, but also in finding a solution to moral conflicts or, more generally , in reflecting around a hierarchy of values;
- Since, through Knowledge, we can create and realize our projects, both in a contingent and existential sense; we can affirm that it helps us to achieve our goals.

In consideration of the above, we believe that it is necessary to plan educational actions that, starting from the identification of the training needs of the adults exposed to the risk of socio-cultural marginality, help them to acquire communication tools to develop orientation and self-protection in the global world. As for the training needs of these subjects, we also report their difficulties in relating to minors and their educational relationship.

To this end, it is useful to highlight both the risks and the resources connected to the use of the Internet and, in general, of the new communication technologies, starting from the awareness of the new social and productive dynamics.

Grammatik acted with multimedia languages, their virtually, paradoxically less “virtual” than the bookish and scholastic one, meets the need to recognize in the instrument a connective valence with one's own person.

It is in this subject-machine connection that opens the door of a dive, of an inclusion with a world that magically appears on the screen to open the doors of fantasy, play, action and a certain form of thought.

This immersion further reduces the level of abstraction proposed by the computer experience, since the subject can be projected into a mechanism and a process of exploration of knowledge, of narration of one's own experience, of constructing the sense of one's symbolic universe.

So, if the computer represents a sort of extension of the self and, at the same time, a rarefied environment to inhabit, the subject himself becomes part of that environment and can be inhabited first of all by himself and then, through the construction of relations with the IT tool, finally, by the meetings that it allows and solicits.

II.4. Analysis of a possible proposal: reduce risks and enhance benefits

Considering the considerations made so far, as of the most recent international research, we believe that the use and enhancement of MOOCs can be an effective proposal, especially for the weakest, for those who are at risk of cultural marginalization, for those who need cognitive support, for the following reasons:

- Thanks to online delivery can be used massively and free of charge by many students who can create or join social networks. In this way, they can simplify teaching and contribute to the formation of a critical spirit;

- Promote internationalization and therefore the possibility of acquiring credits recognized at European level. Consequent-mind promote the dissemination of ideas and new interactive methods;
- As they promote autonomous research activities, they favor the multi-interdisciplinary interaction facilitating the elaboration of flexible cognitive maps.

However, there are also weaknesses on which to watch:

- Reduce the direct proximity between teacher and student;
- Difficulty in creating laboratories or experiences that require dexterity;
- Easily reach students who already have a high level of motivation to learn.

To obviate these shady areas, we believe that a clarification on the deep semantics of new training technologies is indispensable for students, teachers and researchers.

In hypothesizing a sort of "Guide" to the competent use of MOOCs we think that it must pursue these objectives in helping the subject a.

- Identify, based on their training needs, a selection of topics to be explored also in the light of plural operational approaches;
- Analyze the cognitive tools of parity in the light of the objectives to be achieved;
- Interpret information based on one's life experiences and work needs;
- Reflect on the functionality of knowledge and on their metacognitive value in order to transform them into transferable skills to different situations and contexts;
- Take possession not only of the contents, but also of the processes of constructing the knowledge and the models of thought.

The hypertextual dimension of MOC lends itself to interesting considerations. The hypertext is consulted from different points of departure, autonomous and independent; it escapes the linear succession

of chapters and paragraphs of the book, where this characteristic is recoverable only at a conceptual level.

The hypertext dialogues through the graphical interface whose information is organized in such a way that the user chooses his own reading paths, adding links or materials.

Those that we have listed are therefore the same characteristics of paper and alphabetic code, enhanced by the enormous technological potential of the interface with its cut-and-paste functions, find-replace, zoom display, fast scrolls.

The hyper textuality transforms the book into electronic text, in bytes, deprives it of its paper size, which can be recovered only by printing, or better, by downloading the document from the computer.

However, at the same time, it associates it with the other codes with which it interweaves a system interrelation, a sort of formalization of formalizations.

Moreover, the hypertext allows the reader to intervene within his own structure transforming it into a sort of co-author, since the space of information technology transcends the physical limits of the materiality of paper and sheets, allowing each person to bring significant transformations to the construction of their own paths of knowledge.

In this regard, these core areas of competence have been identified:

- Linguistic-communicative;
- Technology;
- Of the sciences called "Human" and of the "scientific" sciences ("hard" sciences).

Finally, a border area is identified, an intersection that allows the human sciences and the hard sciences to communicate on complex problems.

The combined interweaving of multimedia language codes, on the one hand, presupposes strongly connatural linguistic units, as the image conjugated to sound and movement typical of the television language on the other leads to new conventions of use of the alphabet.

The latter process involves the formalization of a technique, the alphabet precisely, already in itself intensely formalized, with a high symbolic and therefore strongly abstract.

A curious combination unites opposites, or those that appear at first glance:

- connaturally and abstraction;
- orality and writing.

The image-sound-movement, the alphabet and its new use and enriched with paralinguistic and ideographic elements, such as smileys, or onomatopoeic elements that are traditionally foreign to them, have given rise to a new language and, with it, of unusual metaphors of knowledge, of different gnoseological approaches.

Thus, not only abstraction coexists with connaturally, but also orality creeps into the thought desk. The synthesis in the analysis.

The interweaving of codes that multimedia implies reflects the nature and complexity of these links that are always socio-anthropological and therefore linguistic and that intersect on different levels, surpassing a structure that escapes the traditional reading tables. In addition, it is for this reason that today more than ever it is fundamental "to know the knowledge".

"Knowing our knowledge" (Morin, 2007) means making explicit decisions and values. If, as Foucault states (2001, p.119), "the practice is a set of elements of transition from one theoretical point to another, and the theory, the passage from one practice to another", the practice, in pedagogy and in the formation of technology, it is practical and theoretical.

The "transition from one theoretical point to another" as well as "from one practice to another" is determined by a criterion of judgment that establishes a relationship of meaning. What are the consequences of these conclusive reflections on the epistemologies and educational practices that are conveyed by new technologies? In light of these

considerations, the technologies are the tool and product of the knower, during its construction.

Every learning made by technology, even the one considered immediately practical, technical, instrumental, has an existential thickness that pertains to our symbolic multiverse, fuses mentalization and execution, represents at the same time an instrument, product and educational content. It is our poor systemic knowledge (Bateson, 1984, p.27) that does not allow us to see the relational and dynamic fabric of the training experienced by and in techno-logics.

In light of these considerations, we believe that training technologies such as the practices that they activate are theory and educational fact, but, at the same time, they produce one and the other.

Their pragmatic logic must first be deciphered, then integrated into a procedural and relational hermeneutical system, through the elaboration of propositions able to place the phenomena in a coherent and elastic system of cosmovision.

In our opinion, these fundamental junctions can find further variations in disciplinary teaching:

- develop together with students' meaningful paths around the paradigms of the technological society, in order to favor a work of epistemological conscientization;
- set up flexible multirelational and multimedia models that reorganize the disciplinary know-how around key themes for the present;
- study the linguistic rules that characterize the communication of training technologies, or the patterns through which they structure discourses;
- which means recognizing both the grammar and the semantics together with the formative value of its discursive conventions;
- this helps us to explore the training potentials of technologies as forms of organization of thought;

- create, together with students, new structured representations of knowledge in the understanding of the metacognition valence of training technologies. In fact, network interaction implies a logical, emotional, sensory, sensory-motor immersion of the subject who learns and works simultaneously and who simultaneously connects meanings from one co-member to another, following concept maps, intellectual strategies, emotional paths, aesthetic vocations, value choices. The human and social situation lends itself to a less univocal reading than that suggested by the epistemology of the book, a reticular reading that recovers oral rituals, and at the same time exalts the suggestion, the emotionality, and the rationality. Hence the extraordinary formative value of the multi-media: in its complex meta-cognitivity. The person who acts in an expert way in the computer world, for example in hypertext, builds knowledge in the elaboration of relational textures that unfold between different languages and then uses different forms of intelligence at the same time. It is open to multiple cognitive approaches, collects information with a logical, emotional, aesthetic, sense-motor procedure. It does not refer only to abstract thought but uses the various intellectual strategies that underlie the different linguistic forms. He uses a connective thought in a creative sense and is ready to reconfigure his theory of knowledge in the face of new cognitive experiences. But we are talking about the expert sailor;
- “know the knowledge” starting with explaining “what's the use” - because this is the recurring question that our young interlocutors ask us and this is the pragmatic logic that the technological society pursues to reach, to understand the “thing” is”.

The objective of this training is in the construction of “ability to manipulate models of explanation, execution and regeneration of

systems of dominance related to the expert development of the areas of experience and cultural studies" (Margiotta, 1997, p 76).

That is in the formation of a connective pen-serum, in the ability to act differently at different cognitive approaches, different forms of intelligence; in the refinement of cognitive solidarity.

Another proposal concerns the scholastic and academic curricula available to the disciplinary opening, which, however, does not disregard the use of scientific specialisms. A method - of teaching, study and research - which, consequently, presents itself as a process of reflection and for reflection, open, generative, plural, uncertain, and, in turn, relational and procedural, because able to be transformed during the journey. That is to learn.

This knowledge not only offers the tools to build reading keys and orientation maps, but also helps to independently seek answers to the need for identity that, especially young people and adolescents, express in their delicate phase of growth.

An identity that actively and critically participates in the self-determination processes that accompany young and old adults towards their becoming aware protagonists of their time.

CHAPTER III.
From Constructivism to Metacognition for Significant Learning

To analyze teaching learning processes and it is essential to refer to how thinking works in the processes of knowledge construction.

Since we are interested in teaching processes supported and integrated by technologists, it is essential to start, in particular from how the construction of knowledge correlates with artefacts.

It is this perspective of approach that makes the existential meaning of Knowledge fundamental.

The sense of Knowledge is divided into three fundamental elements:

- **Epistemology;**
- **Ontology;**
- **Ethics** *(speculative investigation of the practical behavior of man).*

The concept of epistemology, **science**, and the epistemological frame of reference becomes fundamental, to the extent that, especially in the teaching-learning processes, knowing "*how things are done*" does not help much if you do not know "*what things are*" (Gramigna, 2015).

An epistemology that influences the evaluation of both students but also determines the tools used in the teaching-learning process.

This new millennium, for didactic research, is an open construction site; a field of development and research that in these years presents a great variety of ideas and a ferment of innovation.

In all this set of ideas and processes it is possible to identify certain fixed points.

We must consider the didactic research and the training of teachers, actors in the teaching-learning process; teachers who are not only called to define the educational processes but also to contribute decisively to the definition and creation of cognitive artifacts; cognitive artifacts that become an integral part of learning.

The theoretical support is connected, though derived from the point of view of microteaching[1], with Bruner's theory of education, as developed from the early 1960s.

It can be said that, in this context, we can make surveys of teachers' practices and artefacts to make them understand their meaning and purpose during classroom work and individual study (Damiano, 2005).

It is a question of resuming the concept of "stimulated recall" of experience, in the perspective of an analysis of teaching practices using artifacts.

Educational practices that focus on reflections not "above" but "inside" the teaching and the educational processes.

A teaching that expresses "tacit" thought of the teacher and is an expression of "epistemology of practice" as well defined by Donald Schön, who also states that "according to the model of Technical Rationality the professional activity consists in the instrumental solution of the problems made rigorous from the application of scientifically based theories and techniques" (Schön, 1983).

This perspective defines the direction of research and places the focus of attention on established mediating processes.

---

[1] Kim Romney and Dwight Allen (Stanford University 1963) coined the term **microteaching**. Microteaching arises as a training practice for teachers and as a tool for pedagogical research. Microteaching aims to provide teachers with elements for the analysis of their teaching practices. The teacher has "*the possibility of acquiring the techniques and skills necessary for the best possible development of the profession*" (Allen and Ryan, 1974, p.29) and "*greatly enlarges the dimension of feedback*" (ibidem, P .26).

The mediating processes can be, for example, cultural objects or physical spaces; in this context, we will deal with aids and cognitive artifacts that are placed between the actions of teachers and those of students, thus acting as a framework for a didactic action that consists in modulating and using these elements effectively.

For these reasons, the specificity of the research direction to which reference is being made has peculiarities that distinguish it.

In particular, the development of research privileges the product, the artifact, to enhance the different modes and the different teaching-learning processes.

This perspective makes it possible to enhance the different forms of teaching in direct consequence of the effectiveness they demonstrate in producing learning, that is, "*teacher effectiveness*", to enhance the student's learning processes, while highlighting the design and maieutic skills of the teacher.

This perspective of didactic research, reflecting on the model, derived from the previous research methods, focuses its attention on the meaning of the didactic action bringing to light the characteristic asymmetry of the educational relationship.

This line of development, in addition, starts from the enhancement of disciplinary teaching and comes to justify a full and distinct autonomy of teaching as a process of mediation of knowledge.

This perspective derives from having evaluated the proposed model, from previous research, the result of a simple analysis of the characteristics of teaching and derived in a simplistic way from the theories of learning, from a psychological and sociological point of view.

In this context, it is essential to underline once again the concept of knowledge to which reference is made.

The concept of knowledge, analyzing the teaching-learning process, is a function neither of the "**subject**" nor of the "**object**". The concept of knowledge is the constructivist interaction of both (Damiano, 2006).

We are therefore witnessing an important change in the epistemological foundation of the sense of knowledge along the path already widely traced in psychology by Piaget (1971) and Vygotskij (1978).

With these premises, it is easy to define what are the characteristics and the roles that are integrated in the role of the teacher.

In particular, this definition of roles and characteristics is justified because if a knowledge "is constructed through a complex and non-linear interaction, a mediation that takes place between numerous and composite elements - corporeal, emotional, affective, operational, cognitive, symbolic [...] able to give shape to autopoietic structures, derived, but relatively autonomous and self-existent" (Damiano, 2005, p 239).

These reflections have the consequence that those who teach cannot avoid questioning about knowledge, its forms, its operations, its acquisition processes and the artefacts that convey it.

On the other hand, those who teach are called upon to consider their real scope in their didactic action; the teacher must feel a real role as researcher and experimenter in the educational process.

The role of the teacher's researcher is summarized in the three points that describe the passage realized by the "teacher effectiveness" of the 80s: **from** "The know-how, it is only applied; the tools are there, just use them, knowledge ceases to be "research" when it is "intervention" **to** "the didactic action is productive interpretation, the tools are built at the act of teaching, the theoretical knowledge is the language of action to teach" (Damiano, 2005, p. 242).

In a field of research on cognitive artifacts and the definition of parameters for evaluating cognitive artifacts, one must also consider the definition of an ontology, **constitution of the real**.

As we understand them, ontologies are structures of shared knowledge, formalized by the scientific community through semantic description languages.

The ontological structure reflects the main nucleuses of a conceptual framework shared by an academic community. An ontological structure facilitates the retrieval of authoritative information and relevant learning materials and at the same time aims to integrate the formal dimension of a knowledge domain. An ontological system is thus defined by a set of concepts and relationships, with the conceptual and relational dimension that develops within the daily work and study practices of different learning and practice communities (Nadin and Rizzo, 2014).

In this perspective, ontology has the potential to become a multi-referential environment to support comparison and dialogue between the scientific world and the teaching world.

An ontology of professional practice, but also a cognitive tool able to organize a disciplinary domain and to promote reflexivity on experience, with a consequent attribution of meaning.

Interaction with an ontological environment becomes an occasion to re-conceptualize one's experiential experience and to identify the best solutions to intervene in professional contexts, with reference in this context to the cognitive artifacts used in teaching-learning processes.

Within a research[2], it was found how the interaction with the ontological environment becomes an opportunity to re-conceptualize their experiential experience and to identify the best solutions to intervene in educational contexts.

This research and the ontological context are relevant for the definition of evaluation parameters for cognitive artifacts.

The theoretical framework mainly refers to the cycle of "*experiential learning*" formalized by Le Boterf (2000).

---

[2] **PRIN** (**R**esearch **P**lan of National **I**nterest) 2006-08 "*Ontologies, learning objects and communities of practices: new educational paradigms for e-learning*", national responsible prof. Luciano Galliani.

The starting point defined by this research is the experience experienced by the subject, involved in a project or in a problematic situation or simply engaged in carrying out an activity.

In this way, the lived events are transformed into stories to be told, through a process of systematization of the events, the variables involved, their logical and temporal succession, and the meaning they assume for the subjects.

This narrative follows the phase of conceptualization of experience, in which the subject constructs interpretative schemes and action models and to the de-contextualized product artefacts, that is, of the bearing and invariable structures that support and potentially guide action in a situation.

It is a phase of "*suspension*" in which the subject implements a "*strategy of distancing*" (Fabbri, 1995) from the situation to construct a conceptual representation that allows before understanding it and then acting in it.

He experiences is thus recovered in a new and abstract form to be included within action models that can become reusable paradigms.

Even if in a marginal way, it will have to consider an ethical dimension of teaching, understood as the c*onsequences of acting on the world*.

One cannot forget the ethics in analyzing technological tools and cognitive artifacts from a design and evaluation point of view.

In particular, the ethical dimension is necessary to prevent the risk of being projected towards a technocratic formation that separates the means from the end, the procedure from the method, and the ethics from the deontology.

We no longer have a cosmogony capable of giving a unitary sense to our cultural identity and we are all afraid of losing ourselves.

We must prevent and define parameters that highlight it, that technocratic education does not help our young people to build the tools

for reading complexity, the orientations in the global world, the keys to understanding their existential situation (Gramigna, 2015).

III.1. Constructivism and metacognition

As Piaget stated in his treatise "***Genetic epistemology***", "k*nowledge is a process of continuous construction*".

Approaching the analysis and definition of parameters for the analysis of artefacts and teaching-learning processes that integrate them must keep in mind that our knowledge of reality is an individual and social construction.

With this assumption it is fundamental an appropriate constructivist practice for effective didactics, didactics that integrates artifacts as support but as an integral part of the process of knowledge construction.

This first reflection is not just a theoretical question but has several practical implications:

- give value to the disciplines considered as a historical construct; a construct that testifies to the evolution of the relationship between man and the world, and not as objective descriptions of reality;
- deep rootedness and legitimacy of the diversity between cultures, and the possibility of evolving one's own points of view;
- dignity and legitimacy of the models of explanation of the students that cannot be interpreted simplistically as an error and which must be considered to set up any educational action;
- importance of the constant negotiation of meanings and the uselessness of a notionism;
- development of a metacognitive and reflective attitude that supports the idea of constant learning throughout life.

The constructivist approach offers a theoretical framework from which to derive some important indications on the meaning of learning,

on what to teach and how to do it, which tools and artefacts to use and, as an important consequence, what should be avoided.

If knowledge is an active and personal construction of meaning through mechanisms of assimilation and accommodation, consistent with individual history, a teacher can offer the student stimulus and addressing.

The teacher, however, cannot directly influence learning: "education is not the cause of learning, it creates a context in which learning takes place as it does in other contexts" (Wenger, 1998, p.226), such as family and classmates.

So, the teacher does not mechanically determine learning, which should be seen rather as a continuous process, which sees teaching as one of the many possible resources.

In other words, the teacher can effectively and consciously perform his function, only recognizing the illusory of a direct and causal relationship between teaching and learning.

The teaching function must be an answer, possible but not predeterminable and planned, to the pedagogical aims of the setting it has set up.

In addition, the communication and the action of the teacher can be considered an object among the other objects available for learning.

In fact, what the teacher says and proposes, is always interpreted by the student and the interpretations almost never coincide with what he wanted to convey, as the meaning is reconstructed starting from previous knowledge and personal goals: the teacher and teaching materials become resources for learning in many complex ways, through their pedagogical intentions (Varisco, 2002).

Regarding the use of language by the teacher, we tend to forget that the teacher's approach to symbols is governed by a personal habit acquired for a long time, as well as the way of looking at the objects of a discipline.

The teacher, therefore, has a constantly orientate function in the construction of meaning; through a careful use of language it indicates the direction of meaning and, without offering pre-established answers, raises limitations and outlines a horizon within which to lead in the correct direction (Von Glasersfeld, 1998).

In this perspective, the traditional lesson loses its centrality in favor of direct experience, understood as not only manipulation and construction of objects, but also fruition and deconstruction of different materials and texts.

Even in proposing direct experiences it is good to remember that any perceived is not in itself significant; the "*what we perceive*" is, as we have seen, oriented and made possible by the intentionality of the subject and depends on the internal construction, we could say that it too is an occasion and not a cause of learning.

It is indeed frequent that, during an experiment or an observation activity, students do not literally know what to look at; what for the teacher is of the maximum evidence, remains for the students confused in a background not easily distracted of stimuli that could have all the same importance.

If the acquisition of knowledge takes place through multiple interacting paths, also determined by the different social communities to which we belong, this means that individual learning cannot respond to predefined, linear and segmented standards and phases; it is necessary to offer everyone the conditions to follow their own individual path within a recursive and reticular process, in which everyone can self-determine, through the multiplicity of passable tracks, his itinerary and part of the objectives themselves.

However, the problem remains of understanding better through which paths a subject takes on the forms of interpretation of the culture of belonging.

The recent evolutionary theories of the mind reject the assertion that cultural forms and conventions can be extracted from the social context simply because they constitute the environment in which children grow up; the availability of some underlying skills seems to be essential, such as the ability to keep in mind, to detach patterns from their input-output conditions and to insert patterns within other schemes.

In this sense, the constructive and creative potentialities that Piaget, Von Glasersfeld and the Operations School recognize to the subject in learning should be recovered to research.

In Italy, Alberto Munari and Donata Fabbri have used the basic theses of genetic epistemology, aiming to combine this point of view with the paradigm of complexity (Cosentino, 2002).

With a hermeneutic and negotiation approach, in which the subject must deal with the polysemy of the utterances to decide, according to the situation and the personal knowledge system, what meaning is relevant, having to also share this construction path with other subjects.

If we pass from the common discourse to consider the specificity of scholastic communication, a road is defined that consists in making the exercise of negotiation and hermeneutics enter interaction with strategies that make students able to recognize and act on their own interpretative schemes.

Schemes are structures that organize the memory and that serve to interpret events, objects or situations and to make hypotheses and predictions about them, are interfaced, dynamic and articulated in subtests, their set represents all the knowledge of an individual.

Used in teaching, they become a metacognitive tool, as they allow the subject to express their conceptual network explicitly outside the mind, and a tool for negotiation, as they facilitate exchange and co-construction with the group.

In concept maps, data and information are organized spatially, offering the possibility of simultaneously dominating a field of investigation, of discovering new relationships, of transforming tacit knowledge into explicit knowledge.

In this dissertation, it is also important to see the relationship between metacognition and technologies in teaching.

It is commonly said that "*if I listen or read, I forget, if I see I understand, if I do, I learn*".

This statement tends to underline that there is less effective learning, conveyed by perceptions, such as listening and seeing, and a more effective learning, conveyed by action.

A first sense of learning from doing could therefore be the following: there is a learning that takes place by incorporating information through sensory channels and learning that takes place by engaging in motor operations, a type of kinesthetic of learning.

In this sense, learning from doing could then be understood as a learning that requires the learner to act, try, advance hypothesis, criticize and discuss, as opposed to learning in which it is essentially about receiving, retaining and storing.

You can also be active by reflecting on what you have heard, comparing two concepts, wondering for example if an information is reliable

One can therefore ask whether digital cognitive technologies and artifacts can enhance metacognition.

Digital technologies can increase and expand metacognition because of the possibility they offer to keep track of the actions carried out and therefore to be able to return a report of the activities performed.

You can also be active by reflecting on what you have heard, comparing two concepts, wondering for example if an information is reliable.

One can therefore ask whether digital cognitive technologies and artifacts can enhance metacognition.

Digital technologies can increase and expand metacognition because of the possibility they offer to keep track of the actions carried out and therefore to be able to return a report of the activities performed.

By acquiring a competence of this kind, the student has the opportunity to learn not only disciplinary knowledge, but also more general thinking skills that can apply to other contexts, thereby favoring the flexibility and transfer of learning (Antonietti and Cantoia, 2000).

The work on the awareness of one's own work and the implicit mental processes calls into question teachers as much as the students: for the former it is about organizing opportunities for reflection in the proposed activities, for the latter it is about making a metacognitive reflection on the work done.

Cognitive technologies and artifacts allow new ways of designing teaching-learning processes:

- relationship with objects of knowledge different from traditional instruments;
- solicitation of different mental activities compared to traditional tools.

The intrinsic structure of digital technologies and related cognitive artifacts can be summarized:

- ***hypertext:*** it offers visible advantages in variable and structural paths, in a greater activity and creativity on the part of the user, in a personalization of learning; this characteristic also carries with it the risk of an excessive cognitive and perceptive load;
- ***multimediality:*** an integrated union of all digital information techniques in multiple formats that exploits technological potential; multimedia brings with it the advantages and disadvantages:

- advantages
  - multiple access to information;
  - motivation and interactivity;
  - deepening of knowledge;
  - targeted research.
- disadvantages
  - information overloading;
  - student's liabilities;
  - interference and overlaps;
  - disorientation.

- **interactivity:** possibility of a "media" object to change different parameters as a type of user, consultation time and reaction of the user, to build their own paths of fruition, to activate a learning having as central core the action, to start a reciprocal activity and simultaneous of two or more actors pursuing a certain goal; interactivity has advantages and disadvantages:
  - advantages
    - exchange of knowledge and learning methods;
    - added value of collaboration in processing and production.
  - disadvantages
    - predominance of action on thought and the achievement of skills;
    - specifications at the expense of cognitive abilities.
- **transformability**: characteristic of the "medial" object that allows to simulate situations, changing point of view, which offers the possibility of looking for solutions instead of resolutions and the flexibility of products and procedures of mental processing; the risks of transformability are the confusion between reality and virtually, the illusion of omnipotence, the massification and schematic simplification of reality.

III.2. Significant learning and digital technologies to learn

The society in which we are living is well defined by the term "*liquidity*" that brings with it continuous and complex transformations that, among others, generates a change in the cognitive and communicative modalities of the individual.

In this, new social perspective the constructivist vision of knowledge, that of socio-cultural constructivism provides an answer so that the individual can become the protagonist responsible for his personal and social growth, through a lifelong commitment for life.

From a European point of view, it is the competence of learning to learn, which can be solicited in "learning centered" learning paths, attentive to all the dimensions of the learner's personality: cognitive, metacognitive, practical-operative, affective-motivational and social-relational.

The competence is nurtured in learning environments that enhance the student's natural knowledge and emphasize his active and reflective role in the processes of construction, co-construction and sharing of knowledge and meaning. These are "*authentic*" contexts, in which the communicative and social interaction is realized with other subjects but also with the technologies.

Technologies, from the most traditional to digital and telematics, up to modern social technologies, are "*intellectual partners*" that help to think.

The class becomes a knowledge-building community, in which all members are engaged in authentic tasks, which encourage interdependence, in effective learning, between formal, informal and non-formal knowledge.

The concept of meaningful learning arises within the constructivist paradigm of knowledge and develops in multiple theoretical currents, including socio-cultural constructivism.

Knowledge is a process of meaning construction on the part of the subject, which re-elaborates in a personal and partly arbitrary way already acquired knowledge, sensations and emotions.

This process, however, does not remain limited to the private sphere: in the awareness that the other constructs his own knowledge in a subjective way, he orients himself to the acceptance and understanding of multiple perspectives (Gardner, 1994) through forms of communicative interaction.

The training process abandons the teaching logic, "*teaching centered*", in favor of learning, "*learning centered*".

The teacher is no longer considered an "information disseminator", (Varisco, 2002) the undisputed depositary of universal, abstract and decontextualized knowledge. It is rather a facilitator, a tutor, a coach and a counselor, who guides the student to recognize with awareness and reflexively redefine the plot of his skills.

The development of knowledge is a "*social enterprise*" [3] the result of interpersonal communication, of exchange and exchange within the community to which it belongs, of sharing and negotiating meanings expressed by a community of interpreters.

Hence, the significant learning model widely shared today in the training field, which sees David Jonassen[4] among the most illustrious supporters.

To Jonassen we must, with a contribution in the book Meaningful Learning with technology, of 2008, a meaningful learning definition based on some attributes: active, constructive, intentional, authentic and cooperative.

---

3 The term "*social enterprise*" is used by R. Lesh, H. M. Doerr, in Beyond the constructivism, LEA, Mahwah, NJ, 2003.

4 **David Jonassen** is a professor at the University of Missouri in the School of Information Science and Learning Technologies. Jonassen is an exponent of the theory of Constructivism, according to which knowledge is reached through personal experience through a process of construction.

Learning is active if it actively involves the learner in constructing his knowledge in meaningful contexts, through the manipulation of objects, the observation and interpretation of the results of his interventions.

In this regard, Papert[5], speaks of "*cognitive artifacts*", tools that allow the subject in a learning situation to go into an exploration in which to build their own projects, try out schemes and manipulate concepts and ideas, changing the status of "*consumer*" of information in that of "*producer*" of knowledge, what later the network has identified, albeit from a different point of view, as prosumer[6].

Learning is therefore a process fueled by practical, necessary but not enough to generate meaningful learning.

The action, in fact, translates into learning through a constructive act, which requires an understanding of the task, deliveries and procedures, cognitive and metacognitive reflection on the experiences in progress, the understanding of the "why" and the "how" of the own action.

Learning takes place in a meaningful way even when it involves conscious events, intentionally aimed at achieving a goal and emotionally charged.

Here then the support is not only realized on the cognitive level, but also on the affective-motivational and social-relational one.

Affective scaffolding[7] stimulates, encourages, and approves the student in his approach to expert practice.

---

[5] **Seymour Papert** (1928 - 2016) was a South American mathematician, computer scientist and pedagogist. He worked with Jean Piaget and then moved to MIT in the 1960s to work with the Artificial Intelligence group and with Marvin Minsky. Papert introduces the concept of constructionism into theories of learning.

[6] **Prosumer** is a word portmanteau, borrowed from English, it is formed by the composition of the word professional or **producer**, with the word **consumer**. Already in 1972, Marshall McLuhan and Barrington Nevitt suggested in their book Take Today, that with electronic technology, every consumer would become a producer.

[7] The term **scaffolding** is used in psychology and pedagogy to indicate the help given by one person to another to perform a task. The term scaffolding was used for the first time in the psychological field in an article written by Jerome Bruner, David Wood and Gail Ross in 1976 [1] and published by the Journal of Child Psychology and Psychiatry. This article describes ways of interaction between a tutor and a child who must build a three-dimensional pyramid in wooden blocks.

It encourages active participation, interest and creativity, acting positively on the sense of trust, on feelings of self-esteem and self-efficacy, on empowerment (Spinelli, 2009) aimed at commitment and responsibility, therefore on motivation to learn.

The concept of significant learning considered is related to "a vision of the educational process capable of unfolding individual potentials, in harmony with social demands and in correspondence with the needs of the world of work and the market of knowledge and knowledge" (ibidem, p.28).

In post-industrial society, in fact, new values, models and lifestyles are being established with respect to the past. To the industrial social model, based on tangible goods, there is a social model in which wealth derives from immaterial resources, from knowledge, so much so that it reaches the term "*knowledge society*", attributing it to today's society.

In the knowledge society "knowledge [...] is a private and collective wealth able to ensure the individual a better quality of life and to guarantee social relations based on the principles of equality, respect, inclusion and productivity".

In this sense, knowledge is a common good and should be pursued, preserved and shared as such (ibidem p.25).

However, knowledge is also an individual good "that fits among those fundamental rights of the person of which no man and no woman should be deprived" (ibidem p.26).

Here in the "*society of information and communication*", which has then reached its peak in the "*knowledge society*", it is radically changing the way we process information and share knowledge.

The individual, therefore, to actively and consciously contribute to the construction of knowledge, must be able to develop meta-skills, which allow him, from a European perspective, to move with reflexive awareness in increasingly less regulated contexts.

However, the individual never acts alone. In order to respond effectively to the increasingly complex and fluid needs of the society in which it lives, it is necessary to know how to interact and co-act with social subjects: "*the competent answer must be a network response and not just an individual response*"[8].

Learning in a meaningful way to build and manage individual and collective competences becomes, therefore, an educational priority in the complex, flexible and dynamic knowledge society.

Priority also recognized by the European Union, which, in recommending the key competences for lifelong learning, considers as a crosscutting to all competences the learning to learn.

Learning to learn is active and intentional learning, because it implies constant efforts to organize one's cultural background, identifying, choosing and using strategies, methods, tools and sources of information and training in relation to operational contexts, available times, personal method of study and work, of one's own needs and objectives.

Here is the recognition of non-formal and informal learning, able to contribute, alongside the formal ones, to building and managing individual and collective competence.

It is therefore a question of creating social, meaningful, dynamic and authentic learning contexts in schools, where it is "*possible to transform the knowledge to be regulated into a process of construction and interaction between stable knowledge and liquid skills. [...] At the same time, sharing the cognitive processes with others in a collective path of knowledge construction, urges multiple perspectives of reality and, therefore, an attitude to pluralism as a fundamental basis for integration and inclusion*" (Spinelli, 2009).

---

[8] See Le Boterf Guy, Building individual and collective skills. Act and succeed with competence. The answers to 100 questions, Italian edition translated by M. Vitolo et alii, A. Guia Editore, Napoli, 2008

Learning to learn also means cooperative learning, because it is the competence through which it is possible to develop not only an action and react, but also a conscious and responsible co-action, which positively feeds the motivation to learn and facilitates the construction and development of collective skills.

In the socio-cultural constructivist theoretical framework, significant learning environments in which to build, co-construct and share a model of knowledge that considers the characteristics of the knowledge society, can be supported by digital technologies, cognitive artifacts and network technologies, including emerging social ones.

In the socio-cultural constructivist theoretical framework, significant learning environments in which to build, co-construct and share a model of knowledge that considers the characteristics of the knowledge society, can be supported by digital and telematics technologies and by emerging social technologies.

ICT (**I**nformation and **C**ommunication **T**echnology) can become artifacts, tools, meaningful learning tools, if they provide students with opportunities to learn with technologies and not technologies (Jonassen, 2008).

The technologies, appropriately defined by Jonassen "*collaboration tools*", can promote collaboration, cooperation and distribution of knowledge in knowledge-building communities; make possible and support dialogic processes, then conversation, discussion, productive confrontation, negotiation of meanings, consensus building, implying a commitment by everyone to reflect critically on a "*progressive*", improving of knowledge.

At the same time, the technologies contribute to promote the development of attitudes that characterize the affective-motivational sphere, becoming an important partner able to offer scaffolding, a scaffolding in the development of knowledge and skills (cognitive

scaffolding) and in the maturation of skills also at the intrapersonal level (affective scaffolding).

The "*areas of proximal development*", in fact, include not only the people (teachers, experts, most capable companions), but also the technologies, both traditional ones, both digital and telematics, up to the most recent social technologies, which possess the potential to become engines able to act positively on the motivation to learn, interest, participation, commitment.

The web, the Web 2.0, the cognitive artifacts conceived as "intellectual partners", can provide the teacher with a valuable contribution for the preparation of learning centered environments able to develop "the competence" of learning to learn, without neglecting the typicality of the forms, styles and learning contexts of children and youth of today.

In the complexity of today's society, in fact, students' everyday life is very different from that of adults.

If the everyday life of the latter is made of digital and telematics pre-technologies or in any case of technologies conceived in the perspective of "digital migrants", that of children and young people today is imbued with technologies.

Videogames, computers, the Internet, mobile phones, tablets and any other kind of similar device are "*lived*" by the "*digital natives*" multitasking, as physical extensions of their body, as normal and natural presence in their living places, constant elements incorporated simultaneously, spontaneously and with extreme naturalness in personal and social practices.

The explosion of the Internet and the globalization of the network, the diffusion of the Social Networks and the Web 2.0 Social Software, are increasingly orienting the screen-agers (Rushkoff, 2006) towards forms of informal, self-directed, participatory learning.

Through an equal system of development and sharing of content, young people take on the new role of prosumer, producers and co-producers of knowledge and meaning through bottom-up processes, rather than top-down, and decentralized tools controlled by themselves, rather than from the school institution.

The *place of learning* changes, it is no longer located but distributed, and it is in this world-village or "*third space*" that the young man of today, the ***Homo contextus***, a *connected man*, lives the vast majority of learning situations, continually activating cognitive mechanisms in constant interconnection with others and context.

He evades the physical limitations of connectivity through modern network technologies, which, by exerting a strong power of fascination, stimulate a plurality of experiences and exalt multiple and collaborative forms of knowledge and communication.

Technologies can really contribute to fulfilling that important task of spreading knowledge on a universal level, understood as a common good.

Digital and network technologies, emerging social technologies, therefore, must be thought of as instruments capable of breaking down technological and economic barriers, of breaking down the digital divide that is the cause of the knowledge divide, for the effective globalization of knowledge, for an aware access to information.

CHAPTER IV.
Representation Systems of Knowledge: an Experience of Representation of an Ontology

IV.1. Introduction

The relationship between ontology and technology has deeper roots than is immediate to perceive and this relationship can be sought from the meaning that these two terms have in their own linguistic derivation.

On one side there is the ontology term composed of òntos (from the Greek ὄντος genitive singular of the present participle of the verb to be) and lògos (from the Greek λόγος, the discourse or the reasoning) for which literally "discourse on being".

From on the other hand we have the term technology derived from the Greek tekhnologhia (τεχνολογία composed of art and speech or reasoning) which means "discourse on art" understood as knowing how to do, expertise or know how to operate.

This first analysis shows that both ontology and technology are concerned with finding methods of representing knowledge that are instilled in know-how, just as the term ontology has been defined in computer science where it assumes the meaning of a formal, shared and explicit representation.

On the conceptualization of a knowledge domain or an area of interest, this definition can be summarized according to formal rigor in the assumption that an ontology as a formal, shared and explicit

representation is *an axiomatic theory of the first order that can be expressed with descriptive logic*.

For this reason, a technological environment that represents an ontology, whose realization has been one of the objectives in the theoretical and practical definition and implementation of the EduOtoWiki environment, reflects the paradigms of both technology as a discourse on art (in terms of "expertise" and "know how to operate"), then those of formal ontology.

The term formal ontology in the field of artificial intelligence, and in the field of knowledge representation, identifies the descriptive tool of the data structure that contains the entities and relationships relevant to the domain of the chosen knowledge, to formalize knowledge and allow inference.

The development, although certainly not exhaustive, of this theme, that is the relationship between ontology and technology that is expressed in an ontological representation in a technological environment, cannot be separated from a theoretical framework that outlines the lines of development of the sciences that around the problem of representation and transmission of knowledge have developed.

Placing a focus on what it is, but above all, what it could become, the use of interactive and portable tools able to provide functions management for these processes of representation and navigation of knowledge with a view to a broad and effective transmission and effective and a semantically categorize sharing of knowledge.

The development of the relationship between ontology and technology that is expressed in an ontological representation in a technological environment will unfold through three main points:

- **cognitive** interfaces and representations and "navigation" of knowledge;
- **analysis** of the EduOntoWiki experience;

- **new human-machine interfaces** and the perspectives of representation and navigation of knowledge.

It can be said that we are following a path that recalls the definition of cultural interface, a term that Manovich[1] uses to describe a human-computer-culture interface, meaning the ways in which computers present us with concepts, relationships and functions with which interact with them and manage them.

We are not dealing with a computer or with a generic technological artifact but with a culture, a knowledge encoded in digital form.

A technological environment for the representation of an ontology, in this perspective, is an instantiation of a concept strongly linked to new media that transform that state that saw, in traditional communication, the object as composed of a form and a content and distributed through a medium, a medium, in a new paradigm that sees transformed the concept of form made part of the medium itself and incorporated into the interface (L. Manovich, 2002).

IV.2. Cognitions and representation

In each model and, more generally, in every communication project two components are fundamental: the "representation" of the contents and the interface of the tool that one intends to use.

These components become fundamental if we are talking about digital tools and artefacts and therefore interactive, in consideration of the fact that interactivity is the specificity, the real benefit of the digital tools themselves (Garavaglia, 2010).

Interaction and representation are fundamental characteristics of the communicative process with digital medium; they represent a determining factor where in a clear way "the medium is the message" (McLuhan, 1967).

---

[1] Lev Manovich has formalized the first systematic and rigorous theory on new media, inserting them into the history of visual sciences and the evolution of the media world.

These design attentions are even more important if the instrument that accepts the representation of information and allows its fruition is the network that has transformed from a medium into a place and from a place is now a communicative format.

The interface must bear in mind that "[...] in the development of new systems and applications, we are not simply building new tools for working with objects in a pre-existing world. We are creating new worlds. IT systems and software are becoming media for the creation of virtually: worlds in which software users perceive, act and respond to experiences" (Winograd[2], 1987); designing and marking an interface, static or dynamic, means building a world that generates an orientation praxis necessary to interact with it.

This method of planning must always bear in mind the paradox of technology (Norman, 2005), which has among its most effective indicators the "creeping proliferation of functions", for which a technology born with the aim of simplifying the processes run the risk of becoming self-referential, self-gratifying with the continuous addition of new functions, often useless when not required.

Observing and addressing the concept of cognitive interface with this perspective, immediately recalls the concept of cognitive ergonomics[3].

---

[2] Terry Allen Winograd is a professor of computer science at Stan-ford University, is interested in "philosophy of the mind" and "artificial intelligence" and is the author of interesting studies of computational linguistics of which he is a pioneer having developed the SHRDLU System since 1972. "The SHRDLU system, using a graphic screen, shows the user a virtual environment consisting of a flat surface, a box and a series of colored objects with a cuboid or pyramidal shape. The user, in English, can interact with an imaginary robot arm to move objects. The mechanism for understanding what was risked by the user consists of three phases of analysis: syntactic, semantic, and deductive. The program block that deals with the semantic analysis interacts with the other two modules. The program can solve many ambiguities of the English language, for example, it is able to understand which object it refers to even when this is implied." (Source Wikipedia)

[3] Cognitive ergonomics is a science that is the daughter of what in the 60s was called "psychotechnical" (psyche (ψυχή) = soul, mind and techne (τέχνη) = art) or "art of the mind", defined and developed through the homonymous school of specialization at the Catholic University between 1960 and 1966.

After the concept of cognitive ergonomics, it becomes important to refer to the fundamental cognition if we intend to arrive at a concept of "semantic" representation of a cognitive domain, remaining as independent as possible / neutral with respect to the context of fruition.

Cognitive ergonomics is to be understood as the part of ergonomics that is of interest and has as its object of study human-machine interaction, a machine more specifically intended as access tools, "navigation" and information processing.

The interaction therefore man-tools of information processing is studied through the cognitive processes involved, perception, attention, memory, thought, language, emotions to envisage and suggest solutions to improve the interface functions. .

Cognitive ergonomics has had a wide field of application in the study of methodologies and design lines to prevent errors in human-machine interaction through the definition of two fundamental principles that must guide the design according to the minimization of the possibility of errors due to a wrong interpretation of the functions of the interface itself: the gulf of the execution and the gulf of the evaluation (Norman, 1995).

The *Gulf of execution* postulates that there is a substantial difference between the intention and the action performed, and between the action and the evaluation of the result obtained.

These principles allow us to deduce that in the design of interfaces we must allow the user to act without further efforts to interpret the instruments (gulf of execution) and the need for feedback is aimed at the certification that the action request was made as desired and on the other to overcome some critical technologies such as the inability to correct a mistake made or to notice too late the error when, for example, the system is blocked (gulf of evaluation).

Cognitive ergonomics has then had several developments that cannot be ignored in the perspective of representing and "navigating"

knowledge, cognitive ergonomics has placed greater attention to what are the cognitive processing processes.

Information that is the semantic network underlying the cognitive processes declined in interactive processes.

In parallel to these lines of research in the 90s the **cognitivist paradigms** and those of **Human Information Processing**[4], the aspects of web usability and the study of the co-efficient aspects of the interfaces and information systems, and the themes of social ergonomics have also developed (linked to the interaction and cooperation between several social actors in the working contexts as training) fundamental for understanding the development of the representation of knowledge in interactive systems.

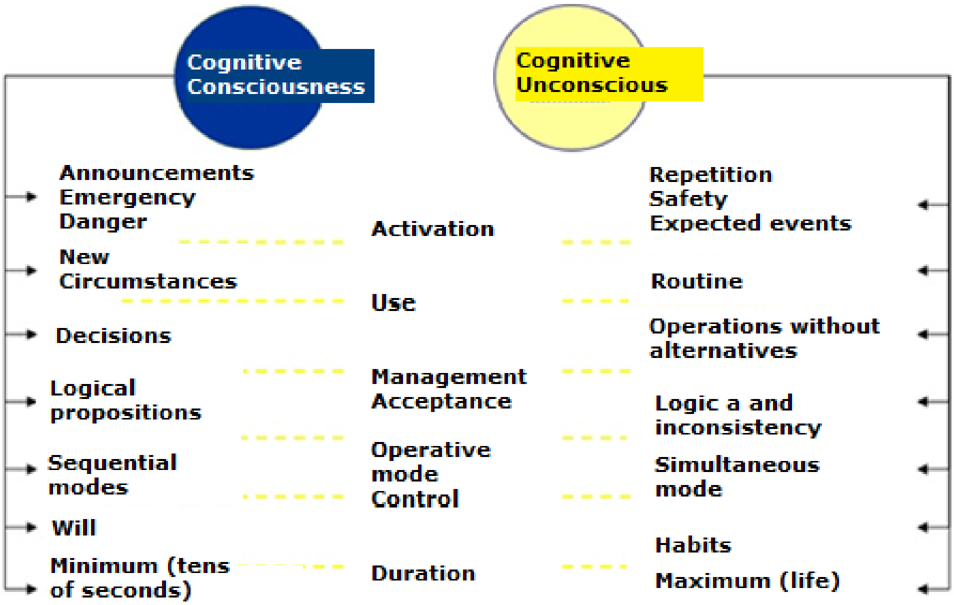


Figure no. IV.1. Scheme of the properties and values assumed by the conscious and cognitive unconscious.

[4] Interesting paradigms to remember in this context are:
- what is simple remains such;
- do not damage the user's work;
- do not waste user time.

As far as "cognetics", *the ergonomics of the mind* (Raskin, 2003), are concerned, on the other hand, in order to arrive, as stated, a "semantic" representation of the contents becomes interesting to briefly dwell on the concept of cognitive and cognitive unconscious conscious.

It becomes interesting to know what the characteristics that distinguish these conscious" are and what are the parameters that can be applied, which values assume for each of the two modes.

Both the conscious and the cognitive unconscious can be parametrizable through the following characteristics or properties:

- Activation
- Use
- Management
- Acceptance
- Operative mode
- Control
- Capacity
- Duration

The properties stated take on determinable values according to the scheme shown in Figure no. VI.1.

These considerations combined with the evidence that the *focus of a user's attention*[5] is unique and that it is possible to make conscious the cognitive unconscious, but not vice versa, show that it is not possible to disregard a cognitive approach in the design of cognitive systems and interfaces for the navigation and the semantic representation of knowledge. These mechanisms are not related to the context of "learning" or "effective navigation of knowledge", but they are intrinsic rules.

Having to deal with representation and navigability, Web Usability becomes fundamental both because, as stated, the network has become a communicative format and because usability is a term that too

[5] The focus of attention in the physical world is the object or idea to which we are thinking in an active and deliberate manner; in an interface the object selected in a given instant in a screen is the focus of the attention that evidently at a given time instant corresponds to one and only one of the objects of the interface

often is confused as a synonym of accessibility, but which instead poses semantic problems and not technicians.

Usability is not a question of code and compatibility has the objective that the tool responds to the needs of the user according to the different needs, motivations and individual characteristics.

The concept of usability itself is considerably complex and multidimensional and the assessment of the usability level depends on these indices, including for example relevance, efficiency, ease of learning and flexibility, which have a specific and different weight depending on the application domain.

Particular attention in the context of the use of interfaces for the navigation of ontologies assumes the index of ease of learning because it measures the ease with which non-expert users reach, in a reasonably rapid time, a good level of use of the system.

The ease of learning, together with the individual satisfaction indicator, is identifiable as the easiest usability feature to measure, in relation to the fact that it is enough to test users.

Possibly, at a low rate of computerization, who have never used the system and measure how much time it takes to achieve a good level of confidence with the system.

Usability offers tools and methods that can be used to complete what accessibility leaves only indicated, is the result of observation and interaction processes; usability, that is why fundamental in the application field, the origin and objective of ongoing analysis, is a continuous evolutionary process not a prescriptive structure as is accessibility by its nature.

Before moving on to the analysis of applications, to contextualize them later in the reflections on the tools for the representation and navigation of knowledge, it is necessary to give a further categorization of the possible types of interface.

- **modal**: an interface is modal when the user's focus is not the state of the same, and the interface will respond in one of the possible ways depending on the state of the system; in this type of interface

the modes are manifested in the manner in which the system responds to the user's actions, for example the <ENTER> key produces a line in a word processor or the start of a search for a typed text in a search engine; an interface is defined as fashion if at least one function will respond according to the state of the system;

- **quasimodo**: substantially modal interface in its logical system but for which the state control is due to a persistent physical act such as for example the pressing of the <SHIFT> key to obtain capital letters;
- **monotonous**: an interface for which each user's action corresponds to one and only one result ("Man is an organism too complicated. If fate is extinguished, it will do so for the desire for simplicity", Ezra Pound); if in the non-modal interfaces each action leads to a single result in the monotone interfaces, there exists one and only one way to perform a determined action.

We can therefore say that the representation of a system of knowledge is even more effective not so much in relation to the structural modality that it uses but as a function of the communicative effectiveness of the interface that serves for its management, intended both as consultation and as insertion and modification. of concepts and relationships.

IV.3. Building, representing and browse ontologies: the EduOntoWiki tool

The representation of correlated or semantic correlated concepts undoubtedly has a possible and instinct in the mapping representation.

If then the need is to make a knowledge domain undeniable and usable according to ontological logics, it is undoubted the value of the conceptual map structure that allows an immediate understanding of the context and ease the metaphor of a navigation where, to use a metaphor rather windy, the wind that propels the ship is the semantics.

A second possible approach that can be defined for the structuring and representation of a field of knowledge is the Wiki[6] logic, if we consider that the domain ontology that we intend to investigate is defined according to the perspective that "an ontology is a con-divided conceptualization".

If in this case we try to make a map of the formalized knowledge domain we get a strictly connectivist map, that is, the concepts are correlated because they are within the same text, this is the relationship that connects them.

We will also find a scale free[7] network with few concepts that will be the origin of most connections and many concepts, most of them, with few if not very few connections.

If in this case we try to make a map of the formalized knowledge domain we get a strictly connectivist map, that is, the concepts are correlated because they are within the same text, this is the relationship that connects them, and we will also find a free stairs network with few concepts that will be the origin of most connections and many concepts, most of them, with few if not very few connections.

By declining these issues, the EduOnto project studied the possible applications of the Semantic Web in educational, training and social contexts. In particular, the project has worked and works to provide the academic, school and training community with an effective tool for consultation, comparison and even learning.

---

[6] Like the Wikipedia itself, the most famous application of the wiki logic, he mentions: "A wiki is a website, or at least a collection of hypertext documents, which is updated by its users and whose contents are developed in collaboration with all those who have access to it".

[7] From a strictly formal point of view, a scale-free or scaling invariance network is defined as a graph that has the property that if we consider the relationship between the number of nodes and the number of their connections, we can see that its graph is of type negative exponential, and therefore invariant for scale changes. The term is due to Albert-László Barabási of the University of Notre Dame (USA) who coined it in 1998. The term and the theory that involves it was developed by Barabási himself in his book "Link - The science of networks".

One of the objectives that the research project has pursued is the development of an ontological structure integrated with a Learning Object Repository for their "smart-people" consultation.

The choice of EduOntoWiki in relation to the final recipients and the areas of knowledge investigated was to undertake a "wiki" approach to allow the sharing and the modification of a knowledge structure in a simple and efficient way or more communities of practices and learning.

In this context, a function has been introduced that gives the possibility to represent and navigate the contents of ontology also through dynamic maps, in particular concept maps with dynamic representation, which could allow a highlight of the connections between concepts beyond the classical definitions **RDF** (Resource Description Framework), a descriptive language for the representation of information, which remains the basic tool proposed by W3C for the coding, exchange and reuse of structured metadata and allows interoperability between applications that exchange information on the Web, but that could make coding lose the wealth of meanings of the relationships that can be found in the definition of an ontology.

When compared these two modes have different specificities, in fact the wiki system is "better" or more noticeably more effective if not even efficient from a "descriptive" point of view, for example with this mode the texts are widely and easily usable, the links are standardize and open pages dedicated to every concept as a whole and there are structures coded for images.

On the other hand, the concept maps with their mapping view have an intrinsic capacity to detect and manage the "complexity", allowing generating a side effect, which is to show the semantic network of ontology in its development.

The experimentation, which accompanied this theoretical reflection, confirmed, as will be shown below, the specificities described

with important underlining linked to the characteristics of the interfaces implemented.

The management from an interface point of view is certainly easier or “user friendly” as regards wiki, since it is now customary for users to use wiki tools, but it must be emphasized that the use of maps.

Even though that the greater complexity of management, due to the fact that there are neither interfaces nor standard tools or de facto standards for their management and very often the interfaces they use are strongly modal and specific, guarantee a great flexibility of use and have the ability to support a multiplicity of structures that allow what is the paradigm of the web: “multiplicity of accesses and multiplicity of paths where the sense perceived by the path made is not indifferent”.

The research project, both in the design phase and in the implementation phase, has encountered difficulties in “interfacing” between the two systems not only due to the intrinsic structural diversity.

The presentation of knowledge but also because the hardware tools do not, they are still so flexible especially in the interaction, where they are strongly linked in any case to paradigms verb-noun or noun-verb.

With the verb-noun paradigm we indicate those modalities for which functions are determined that require that the user first explain the action he intends to perform and then on what he intends to apply the action itself; with the noun-verb paradigm. We indicate those modalities for which functions that require the user to explicate the object first, in this case the “concept”, on which we intend to act then the action that to execute.

The choice of the paradigm is strongly correlated to the simplicity or complexity of the evolution of the system itself, since it is not easy to predetermine whether the number of possible actions on an object will be greater or the quantity of objects on which it is possible to operate.

Finally, it is not marginal to point out that the tools for interacting with the machine, such as keyboard and mouse, are not standardized, for example the mouse can have a single key, two keys or more keys to which functions can be associated.

The considerations purely linked to an optimization of the interface of the technological environment that highlight the difficulties that can be encountered do not diminish the fact that it is necessary to provide a multiplicity of modalities of access to an ontological system.

The richness of an ontological definition of a domain of knowledge is even more interesting as there are methods, tools and functions that allow navigation and interaction "natural semantics".

IV.4. Representation and navigation of knowledge: interfaces and new horizons

Given the importance and necessity in the field of sharing and accessing the knowledge of an ontological approach, it becomes natural to ask ourselves what the ways may be to be taken to make these systems of interface, navigation and representation of the knowledge to evolve and to be "natural".

A first interesting evolutionary perspective is that offered by the Zooming User Interface, also called Zoom World, a user interface conceived by Jef Raskin according to absolutely innovative paradigms compared to the classic interface that had the optics of the simulation of a real environment, in particular of a desk strongly binding the user who, gradually over time, was no longer just the employee who used the computer in the context of his work.

The "zoom" interface aims to break down the very concept of operating system, file name, program and directory-based organization.

According to this system, a user can browse through the contents of his computer through a zoom system; in practice, when the system is

switched on, the user is faced with islands that represent their choice of where and how to find the data they need, for example an island for the central memory, an island for the hard disk, an island for the heart of the system, an island for the peripherals, one for Internet access and so on and all these islands are duly specified with a name, it is not difficult to understand how this can be it is interpreted and flexibly used for any ontologically defined or semantically labeled knowledge system.

The user can "zoom" the island that contains the data starting from the totality of the information contained in his computer and descend altitude, through zoom in ascent and descent, so as it is easy to experiment visiting the planet earth with Google Earth, crossing the documents divided into sections, towards the dislocation of the document.

When the user finds the desired information, he can zoom in until he can read all the information contained in the document: this procedure is equivalent to the choice and opening of a document with a computer having a simulation system of a desk but with a considerably more natural approach.

Once the document has been identified and retrieved it can be directly modified, either a text document or an image with an available and contextual editor, without the need to launch applications, because it is based on the concept of editor and the system provides the appropriate tool for operation, which can be a text editor as well as a palette for computer graphics and image processing.

This data browsing system is certainly more natural, supports the cognitive studies, and highlights how the input tool can be directly on the screen. An example is how it happens with iPhone, and how the manual, therefore tactile input, is co-present with data input through text commands, for example with a keyboard reproduced on the screen or voice with standardized commands.

Let us talk about reality, interfaces and representations, which do not lose, if well designed and structured, nor complexity, because it is managed according to our usual logic of interaction with the sources of information, nor the descriptiveness because the documents continue to maintain all their richness in languages and interconnections.

In this context, also the potential of the **LIM**s (**L**avagna **I**nterattiva **M**ultimediale - **I**nteractive **M**ultimedia **B**oards) is evident, with a special reference to formal training environments, because even in teaching it is possible to bring a wealth of contents and meanings that can be acquired from the navigation of an ontology or a semantic reference network that stimulates collaboration and understanding.

Hence, the strong reference to the need for a design effort because technology can support and "decline" the methodology.

The EduOnto project has opened the perspectives that can be collected as a challenge but with the certainty that the relationship between users and technology has gone from a phase of approach to reach, through a stage of use, a phase of metabolization.

With the three phases identified, it can be defined as follows:

- **approach**: phase in which efforts were made to understand what the potentialities of the technologies were and what their added value was, to traditional communication processes;
- **use**: phase in which the efforts were directed to understand how to use the technologies, their potential and their added value at the service of sharing and the presentation of knowledge;
- **metabolization**: phase in which the instrument has been operated, the interface is for the "transparent" user and allows interaction with the knowledge and with all the actors that that knowledge share and help to grow.

" [...] The ideal personal computer of the third generation will not be a computer.

It is absurd to say, "I have to go to work on the computer": it is not for what you go, but to perform a task, so we should go back to say, "I'm going to write a letter" "I do not go to the computer". To do this, you need an absolutely new approach to the design of these machines" (Norman, 1988, p 283).

IV.5. Outcomes from the experimentation of environments for the generation and use of ontologies

"I'm going to change a branch of the ontology", this is the ideal phrase that, taking up the subject, we probably wanted to hear in some exchange during the long experimentation, but this unfortunately happened rarely. Many of the problems still present today at the interface level in complex situations have been presented at different levels in almost every moment of the experimentation, as shown by the analysis of the results of each individual analytical phase.

Specifically, to analyze how the environments were used, the following experimental model was used, realized through these phases (see also the diagram in TableIV.1.):

1) **pre-analysis**: the environments used were pre-analyzed at the time of development or first choice (in the case of software already available on the market such as Cmap, Freemind, and Mindmanager). In the first case, the instrument evaluation group provided feedback during the development, while in the second case the methods of use of the instrument were recorded, studying the characteristics (the tools already present on the market are basically applications to create maps of Novak through a visual approach);
2) **experimentation**: during this phase some of the experimental processes implemented were observed, trying to understand the

reasons underlying the choice of an instrument and the problems that arose during the work;

3) **collection of data from the participants**: through a questionnaire addressed to a group of participants, the experiences were assessed, the evaluation of the environments used and a series of suggestions;
4) **data collection from the conductors**: through the interviews, carried out following the questionnaire to the participants, it was possible to reconstruct the whole process of experimentation of the implemented ontologies and to collect a series of reflections on the to the environments used;
5) **data processing and final synthesi**s: from the reading of the quantitative data processed, from the analysis of the environments and from the returns of the conductors, successive interpretations were made of the use made of the instruments with respect to the processes.

A first characteristic element of the experimentation is the huge variety of tools used by the groups.

This variety can be explained by focusing what emerged from the interviews regarding the need to make a synthesis between the tool-container of the ontology used and the operations to be performed in other words.

The uses of ontologies were specific and despite some common general aims, different needs have given way to a centering of the interface based on one of the specific needs. At the base of these differences, there is mainly the lack of a definitive tool that simultaneously presents all the necessary characteristics. This characterization of the environments linked to the contexts in which the participants worked, appears very interesting, where the different tools under development have distinguished themselves for the modalities of representation and the possibility of

action (the passage was justified by the possibility of solving a problem with a different instrument more focused on the actions to be performed).

Table no. IV.1. *The phases of experimentation*

Phase	Description of the process	Tools
Pre-analysis	Analysis of the characteristics of the environments used and the restitution of initial feedback with a view to redesigning before experimentation	Analysis sheet
Experimentation	Experimentation of the environments through the different uses by the student / student groups	Observation is method and evaluation grid
Data collection from the participants	Detection of the assessment of environments by users-participants in the experimentation	Tests of assessment
Data collection from the conductors / tutors	Detection of the opinions that the experimentation conductors have made at the end of the entire work	Structured Interview is method
Data processing and final summary	Data processing and summary for the preparation of reports and this contribution	Cronbach's alpha (like indicator) , frequency and percentages in method

Another factor that has further complicated the operations was the unavailability of the tools developed at the beginning of the experimentation, a delay that forced the different groups of experimenters to use software for the creation of maps already present on the market in the first year (among these Mind -manager, Cmap and Freemind).

The software has however presented several gaps regarding the possibility of including full-bodied descriptions, insights, links or attachments to be linked to single entries.

The subsequent adoption of the tools developed, and in some cases even the return to paper, has necessitated a complex work of

transport and reintegration of data (this is not a real migration because the process has rarely been automated).

That has increased the sense of dispersion and disorientation as well as inserting long and expensive work phases that are difficult to internalize as useful.

IV.6. The fixed points with respect to the technology that emerged from the experimentation

From the experimentation, some fixed points emerged, deduced through the analysis, identifying the different forms of requests or as comments on the technologies used. See below:

- Complete transparency: here the reference is to Norman's concept of invisible computer (2005), where the process is everything, there is full correspondence between the natural act, and the result on screen, in practice with complete transparency it should not be no overload operation is present. In the cases tested, instead, it has often had to resort to more technologies and, even when it has been used only rarely, the action has been accomplished in a few intuitive steps. In substance, as for most of the devices on the market, none of the technologies used has been able to exhaust in a few requests to the user all the actions to be carried out and therefore to ensure complete transparency.
- The lack of plug-ins or additional software: some of the tried-and-tested software required the installation of new applications or even additional plug-ins. It is the case of Java, whose installation has been a source of annoying problems and unexpected slowdowns for some participants.

- Regarding point 2, users have shown less reticence if the plug-in or software was already installed on their machine, as the installation operation was interpreted as a mere update that could improve the performance of your PC.
- The need to be able to have the import / export functions to / from standard formats was particularly felt especially by the groups that used more tools to perform different phases of their task. Unfortunately, all the technologies used were rather “closed” making the passage of data difficult and cumbersome if not impossible. The lack of functions considered fundamental by some software would have been less cumbersome had it been possible to implement an easy migration of data from one application to another. Of course, in most cases it was necessary to perform numerous copy-and-paste operations. Naturally, the data import and export functions should go beyond the need to switch from one software to another often and focus its operation on the possibility of recovering and expanding existing databases (think about the DB of an encyclopedic diary) sector that could become the basis for the related ontology).

These points are the outline of the entire work carried out by the participants, who have underlined how the “weight” of this technology has been felt in the moment in which it was necessary to make an intervention on the ontology. In fact, often a simple operation, such as the vision of a regional ontology, entailed a complex series of compulsory operations linked to the difficulty in identifying the interested part or understanding the role of the portion of work with respect to the whole ontology.

In terms of meta-reflection, this aspect introduces a problematic element of no small importance: an interface that makes a more complex operation than expected induces subjects to no longer reflect only on the

delivery received (therefore on the object of knowledge and to an action with respect to it in the case of the example on the regional ontology visited) but also on the operations performed with the instrument to satisfy the delivery (in this case the complexity of operations performed to get to see the desired ontology portion).

The desire for transparency (the first of the fixed points), still present in most applications, is strongly present in all the surveys carried out, as if to underline the intrinsic difficulty of the work carried out with a complex object such as an ontology.

The problem often presents itself in these terms: "*You are asking me to meta-reflect on ontology, but I tend to incorporate my technical operations into my reasoning as most of the time I did it looking for to solve technical micro-problems*".

In this way, therefore, distortions are introduced with respect to the expected process, given that the excessive cognitive weight induced by technology could even take the upper hand over the rest[8].

IV.7. Relevant aspects of the interface

It is remarkable to note how the lack of transparency of the technology has been so high that it has led participants to respond to the questionnaire by including aspects related to interfaces, even when the questions were intended to shift the focus on experience with ontologies in a broader sense.

In particular, the open question in which it was asked to underline the positive and negative aspects of the activity carried out with

[8] This desire for transparency, could not be solved with the current hardware equipment of the common PC, probably we could find new solutions in the latest touch-based interfaces. Think of the intuitive operations of enlarging an image using two fingers in recent Apple mobile devices, multitouch tablets with Windows 7 or multitouch devices with Android.

ontologies (therefore a request that does not directly involve technology) has paradoxically received a rather large amount of answers concerning the interface.

This has allowed us to identify the relevant aspects without having to resort to other tools.

The question was clearly posed, in fact, many responded according to expectations, but the fact that technological questions were always inserted consistently within the answers is an evident sign of an excessive "non-transparency" of the machine in the processes.

The first relevant aspect emerged, considered fairly by some in positive terms and by others in negatives, consists in the possibility of representing relations between terms in a field of knowledge. The participants underlined both the importance of this possibility and its criticality in the moment in which the interface did not allow it to be exploited according to different needs.

In some cases, the same respondent to the questionnaire has inserted this aspect as both positive and negative, explaining how the possibility of representing relationships is a key question of the whole system.

A second element relevant to the interface is the magnitude of the ontology: the participants have recognized in technology the possibility of being able to deal with vast fields of knowledge, but unfortunately, this has been one of the aspects in which the interfaces tested have often failed.

On the other hand, to represent more than 40-50 words on screen while maintaining adequate visual clarity is far from easy, but it is equally important that there are solutions that can reduce the problems of visualization, overlapping of the terms or distances between them and breadth of relationships (see Table no.IV.2).

Table no. IV.2. *Prevailing both negative and positive aspects. The proposed ordering considers the "absolute value" of the items, positioning the aspects that have emerged several times over the top, considering both the negative and the positive connotations.*

Appearance	Score Positive	Score Negative
Practicality-simplicity	15	32
Representation of relationships	15	15
Complexity	0	23
Sharing	22	0
Lexical clarification	12	2
Dispersive	0	14
Cooperation	10	3
Amplitude-breadth	2	10
Exploration-depth	12	0
Switch from macro to micro vision	7	5

A third aspect concerns the visual fruition in the transition from a global ontology to a regional one that is the transition from a macro to a micro look. It is an aspect partially linked to the second because it is always a question of succeeding in restoring the passage from a broad vision to a regional one ensuring the understanding of the positions of the corresponding lemmas and relationships, but above all maintaining the same properties deduced from the representation (for example the distances between the lemmas).

At the root of all the problems seems to be the way of representing knowledge, in terms of the choice options that can be activated on each individual element and the aspects of fruition linked to the vision of both global and regional ontology.

The following table summarizes, based on the use of the tested ontology, which are the main operations to be performed at the interface function level.

Examining it is quite clear that the operations of “writing” (creation-modification) have a lower occurrence with respect to those of “reading” (vision) and that, in the case of creation and modification of relationships, the rap-presentation (vision)) still plays a key role.

It is therefore explained why the three important aspects are mainly centered on the problematic of the representation and the good use of the different representations in relation to the possibility of acting directly on the ontology.

Table no. IV.3. *Identification of the main operations, shown in order of importance, to be carried out in the environment to implement the different uses of the ontology proposed to the experimental groups.*

Use of ontology	**Description of use**	**Main operations (in order of importance)**
Generative	Construction of ontologies in small groups and communities of practices	Creation of lemmas Creating relations between entries
Interpretative	Analysis and review of ontologies	Global vision Regional vision Creation-change relationship between lemmas Creation-modification of lemmas
Communicative	Presentation of ontologies as a support for teaching and learning	Regional vision Global vision
Cognitive	Evaluation through ontologies to support teaching	Regional vision Global vision (creation-change relationship between lemmas) (creation-change lemmas)
Exploratory	Study of ontologies as support for learning	Global vision Regional vision

The difficulties related to the representation of the elements have influenced the creation of a division of the participants in two clusters with different awareness: this distribution is particularly reflected on the answers to the questionnaire question asked to assess the environment in terms of personal satisfaction.

The first cluster is distinguishable from the explication of feelings related to disenchantment and frustration, and is made up of users who,

due to less technical competence, have not managed to overcome the numerous difficulties by having to ask for help and support.

From the most experienced on a few occasions until you feel demoralized and, in some cases, desist or leave the most competent to work.

The second cluster was characterized by the ambivalence of feelings of fascination and obstinacy, arising from the understanding that the instrument has significant potential, but limited by the low usability of the environment, thus making the continuous search for alternative solutions necessary.

IV.8. The approaches tested at the interface

The interfaces developed during the research have distinguished themselves for the representation mode.

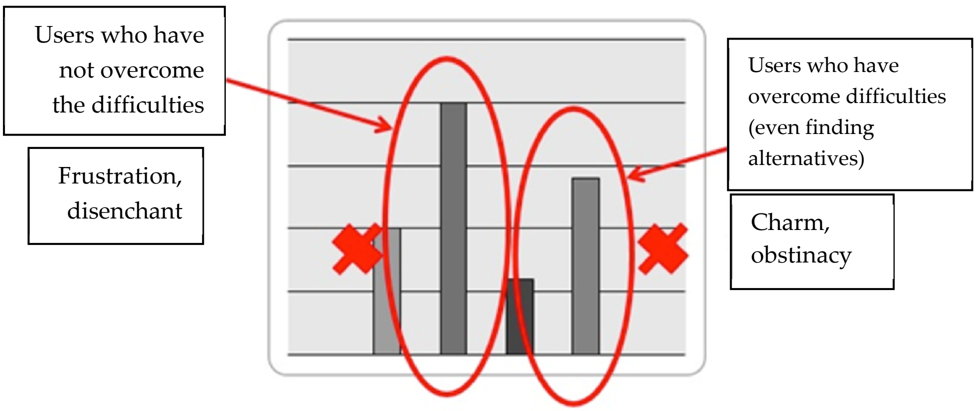


***Figure no. IV.2**. Evaluation of the visual environment (from the questionnaire). The scale varies from 1 = Not at all satisfied to 6 = Completely satisfied. The lack of answers corresponding to extreme values is highlighted, to underline the difficulty of using an environment whose unexpressed potentials are felt. Values as a percentage of total answers.*

To fully understand the substantial differences between the different modalities it is useful to proceed with an analysis of the basic structures underlying the construction of an ontology.

They are:

- **lemma**: it is marked by a label, then an information characterized by a textual code and by an eventual visual representation (generally a point or a circle);
- **relation between lemmas**: the relation presented is a visual information (generally it is represented through a straight or curved line that joins the points corresponding to lemmas put in relation) that a text (label of the report and labels of the lemmas put in relation, then three textual objects and an eventual syntax that identifies the relation with respect to the lemmas);
- **in-depth examination of the lemma**: these are elements complementary to the lemma, corresponding to the text where there can be more complete descriptions, links to hypermedia resources present in the system or on the web.

The diagrams below illustrate this de-structuring: generally, the use of both codes generates a representation mode of an elementary league-lemma-relation-lemma typically displayed as in Figure no. IV.2.

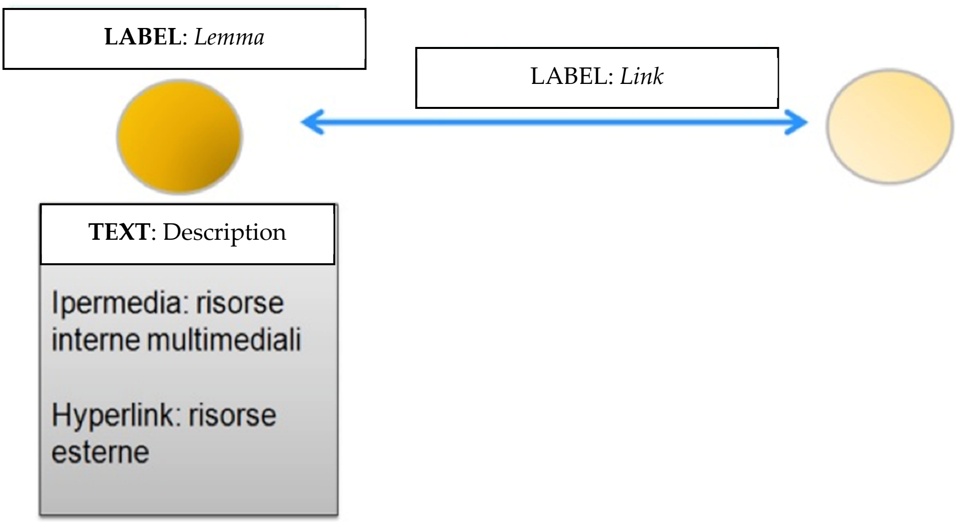


Figure no. IV.3. *Representation of an elementary lemma-relation-lemma bond, where visual and textual codes are used to synthesize the information necessary for understanding the bond itself.*

The use of different codes implies distinct problems in the construction of the interfaces, generally linked to the complexity of the code needed to manage the interactions.

When the type of information requested becomes more complicated, developers generally tend to choose a prevalent or exclusive mode of representation and management of information, with the aim of reducing the programming work and the problems generated by a very complex code.

An example clarifier is the following: let us try to imagine the procedures that a software can ask the user to create a relationship between two terms.

With a visual representation mode, you could make sure that from the icon (a circle) that represents a lemma you can draw a line up to the second lemma by clicking the left mouse button when the cursor is on the first lemma and keep it pressed until that does not touch the circle of the second lemma. Otherwise, using other modes of representation, you will have to resort to other solutions, for example, a text could use a syntax of the genus R: (a, b) or aRb (with a and b lemma and R relationship defined through another syntax).

Following this example, probably many will think that the visual solution is better, and in fact, from the experimentation it has clearly emerged that in the case of few relationships the syntactic-textual solution was not able to restore the clarity of the first, yet it was verified that with the increase in lemmas and relationships vanquished tremendously. The textual solution, on the other hand, has proved to be advantageous above all in the description and integration phase of the lemmas since the available space (in practice the entire screen) has always been adequate and functional with respect to the visual modes.

The choice to make the programming of the online environment converge towards a representation mode or the other is therefore advantageous compared to the complexity of writing the code because

the developers do not have to worry about managing two different modes of operation and representation.

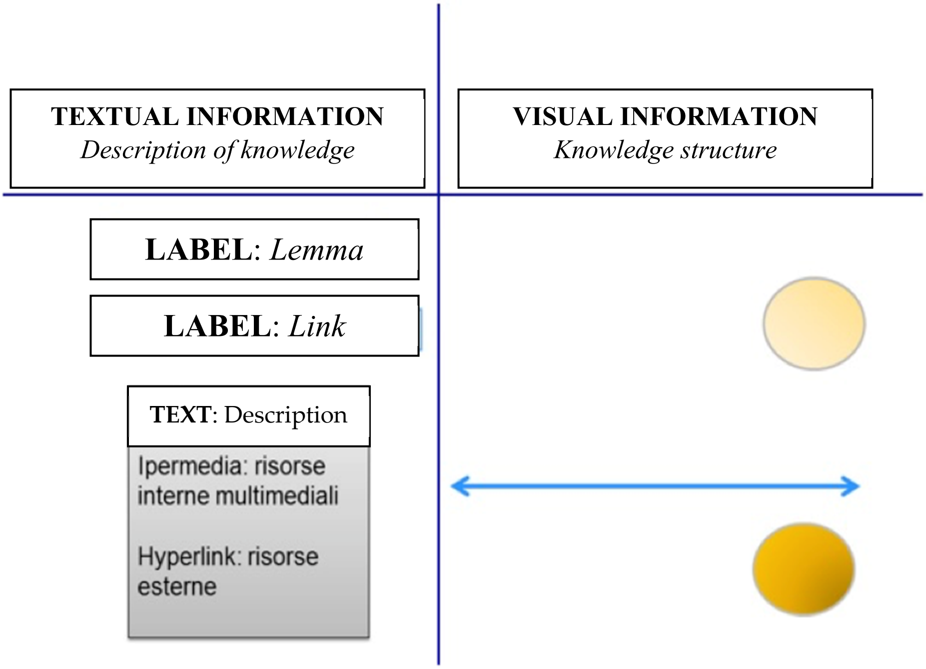


Figure no. IV.4. *The elements constituting the lemma-relation-lemma link are distinguished by code: on the left the textual codes and on the left the visual ones.*

While waivers regarding the usability and in some cases the possibility of making certain operations feasible. The computer advantage was however considered fundamental in the initial phase of designing the environments, precisely because of the excessive complexity, and therefore the experiments were carried out on different environments centered mainly on a single mode of representation; according to the present scheme in Figure no. IV.4.

In the case of experimentation, the various groups have resorted to both software developed ad hoc and to others on the market.

This diversification was made necessary in part by delays in the development of dedicated environments and in part by the impossibility of using the latter at best. Overall, tools were used that referred to three

approaches, one textual, and two visuals of the bidi-monthly and three-dimensional type respectively.

IV.9. Representation with a bidi-monthly visual approach

This approach was initially exploited by most of the experimental groups for three main reasons: the first linked to the need to start work previously to the release of ad hoc developed software, with consequent recourse to programs previously used to carry out similar tasks, is the case of Mindmanager and Freemind.

The second most pragmatic is linked to the greater simplicity of two-dimensional software that allow you to reconstruct on the screen schematics very similar to those already designed previously on paper.

The third is linked to the fact that in the initial part of the experimentation, the ontologies had a smaller number of terms and relationships and therefore they did not yet present visualization problems (in other words the on-logiest were in a single screen easily printable).

With the growth of the lemmas and of the relations, the limits of the two-dimensional visualization have emerged, making it difficult to be able to visualize the relations between very distant lemmas.

IV.10. Representation with a three-dimensional visual approach

The three-dimensional visual approach is the mode of representation of the knowledge chosen for the Jnana software, developed ad hoc for this experimentation.

This approach recovers many of the advantages of the two-dimensional solution by solving two questions: the first inherent in the correct correspondence between visual distance between the lemmas and effective "semantic" distance, since the possibility of "placing at the center" of the three-dimensional space a lemma makes so that more

lemmas in relation to it can be represented respecting a position considered appropriate between the words (and not chosen by the software as being convenient with respect to the free positions on the screen since the bi-dimensionality forces the representation to bend in the form of a hierarchical and rigid tree with respect to the different levels).

The second question resolved concerns the possibility of "zooming" in a simplified and intuitive way between the different parts of the ontology, thus making the analysis of the so-called regional and local ontologies effective.

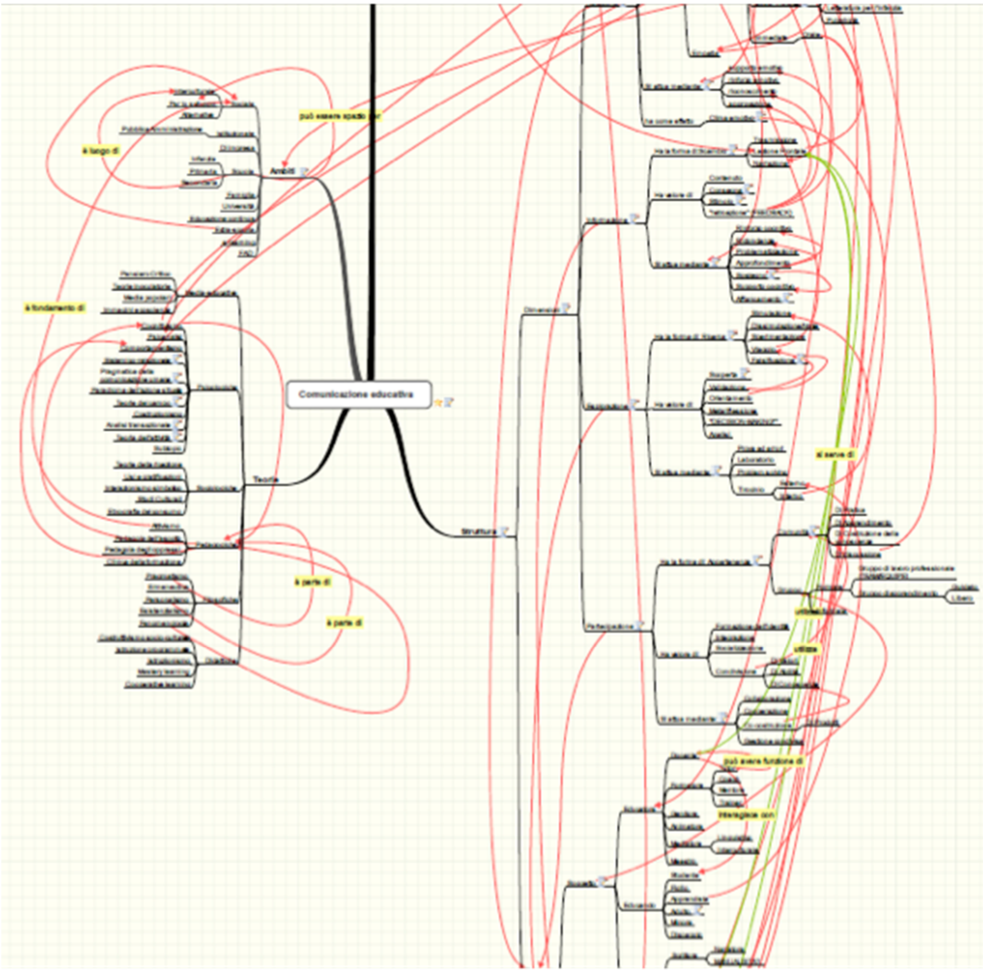


Figure no. IV.5. *Two-dimensional visual approach (Example of a 2D map with link) - Labels are topics and branches are relationships.*

On the other hand, this solution makes it difficult to solve two problems: the first concerning the global view of ontology, a problem that remains common to all modes.

The second problem regarding a certain difficulty in passing between a local framework and the other, solvable partly with further developments and experiments concerning the fruition and interaction with objects in the different visible configurations of terms and relationships.

If we want to compare two-dimensional and three-dimensional interfaces, these interfaces have the advantage of better highlighting the regional structures even in very large areas, while the difficulties have been found in a minor clarity during the active operations on the objects (therefore all that is not mere fruition-observation) because the superimposition of elements on the screen makes the boundaries between them less clear.

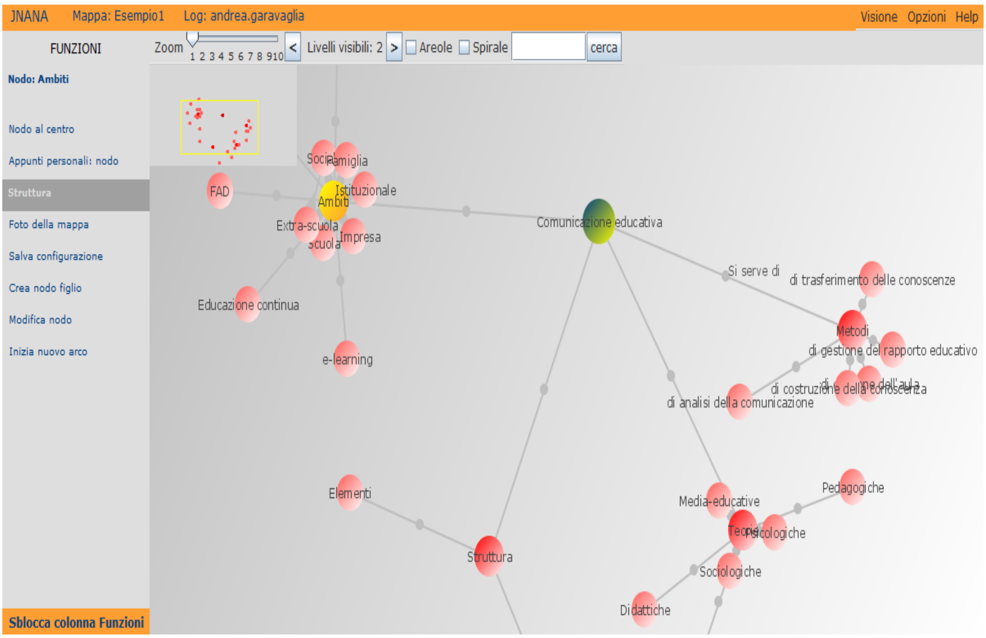


Figure no. IV.6. *Three-dimensional visual approach ((Example of a 3D map with link). Spheres are topics and branches are relationships*

This is a problem already encountered in other situations related to the two-dimensional nature of the screen, the hardware element on which is shown a projection of a three-dimensional perspective.

IV.11. Representation with textual wiki-documentary approach

The wiki-documental textual approach can be considered substantially complementary to the previous ones.

This representation makes it possible to have the descriptions of the well-highlighted lemmas, answering more to the need to insert large texts, and secondly to better explain the relationships through a clear semantic definition.

The tool, built in the form of a web application wiki, lends itself particularly to the drafting of definitions by remote work groups.

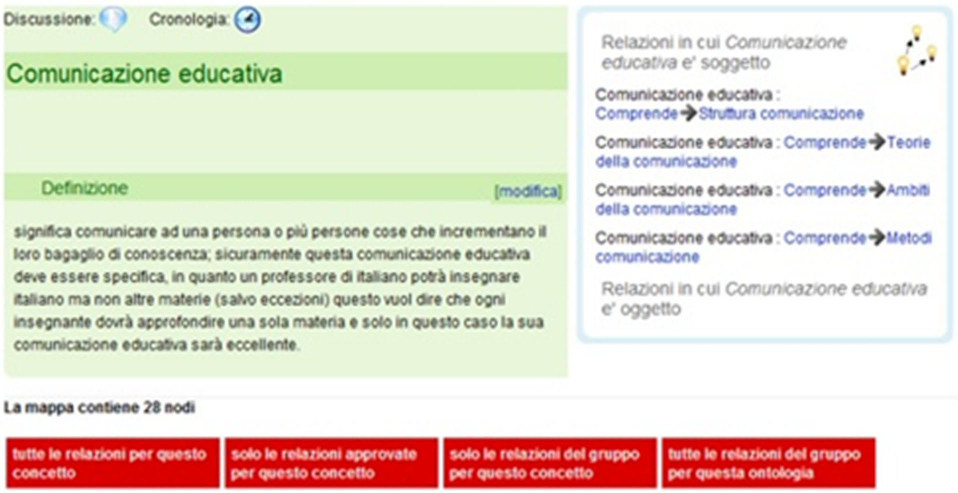


Figure no. IV.7. *Wiki-documentary textual approach (description is in original language).*

In addition to these advantages, unfortunately, a series of problems have been identified linked to the non-integration of a visual approach, including the impossibility of having an overview of the terms and relationships and the enormous difficulty in understanding the

system of relations also in the case of small local ontologies. In other words, the vision of the structure of knowledge is completely lost.

IV.12. Open issues and research areas

In short, it is possible to arrive at some conclusions considering the important efforts made within the experimentation.

First, let's dwell on the problems still open, which can be identified by examining the occasions in which users have preferred (or were forced to) change environment, aware that the passage is difficult (just consider the long passage of data) entailed the possibility of finishing the task according to their own wishes.

The following table summarizes, for each interface configuration, the type of complex action that led to the abandonment of the original technology to return to other known and considered more effective.

Of course, among these are the classic word processor and the printed medium, well known tools and which, although limited, allow a safe operation and knowledge of the operational aspects hardly found elsewhere. The escape from ineffective technology has therefore taken place in the "safe haven".

Table no IV.4. *Complexity that led to the transition to "traditional" tools.*

Configuration	Complex configuration action	Users preferred to switch to ...
Two-dimensional map	Review of the terms of regional maps Vision of regional maps	Word - wiki -carta Word / wiki / three-dimensional map
Three-dimensional map	Global vision and architecture revision Review of the terms of regional maps	Paper-Print of a two-dimensional map Word - wiki
Wiki-document	Vision and Reporting	Paper or two-dimensional map software

Despite the proposal of a resolute environment, that integrates a textual representation with a visual both two-dimensional and three-dimensional (with simplified and immediate steps), the following questions still seem to be open:

- The vastness: any form of representation is not able to return an overall vision except in the form of partial synthesis;
- Disorientation: the figure of the tutor within the experimentation was necessary to monitor and support the process that is always too complex (next point);
- Any form of representation cannot definitively annul the complexity of the ontology that seems.

If the answer cannot therefore be placed totally in the improvement of the software, it is probably necessary to shift the focus of attention also towards the hardware and its characteristics.

Following this line of thought means assuming as main problematic the inadequacy of hardware technology in terms of inadequacy based on the current difficulty in manipulating objects that the classic mouse and keyboard configuration offers us today.

The hard work of observing experimental evaluative practices has shown that despite the extensive online work done with software (Cmap), during the tests in the presence of the students often began to work on paper by acting with their pen in the choice of the correct relationship.

If the pen-based or touch-based interfaces were already widely used (and the operating systems and programming languages would natively support them with numerous libraries), most likely the test would also have been completed electronically.

We could also ask another question: if computers already had touch screens and pen-based interfaces, would the current systems keep current interfaces?

Probably not, the history of computer science is full of cases in which the evolution of a technology has made possible a new interaction and therefore allowed the rethinking of the interface design and the human-machine interaction: the mouse allowed redefining the interaction on the two-dimensional desktop.

The evolution of graphics cards and CPU has allowed compressing the images on the network giving life to the World Wide Web, now we are faced with countless devices that increasingly base the interaction with touchscreen and pen-based tools and the main operating system producers are developing focusing their attention on these new devices that are growing.

It is useless now to make futuristic proclamations; we are not able to foresee the evolution of mass interfaces with such precision to understand if the problems described here will be solved.

It is rather desirable not to forget them to start from the point where you stopped and try to run the best of possible roads.

IV.13. Learning Object, evaluation of artefacts

The development of technologies and their diffusion, and the analysis of constructivist-social pedagogical data have determined the development of interactive and multimedia educational resources.

This wide range of resources and learning objects are a precious asset for students and teachers; teachers can use these resources for a personalization of teaching-learning processes, both in the classroom and for individual study.

In general, we will refer to the concept of **L**earning **O**bject (**LO**), as defined by Wiley[9], as any type of digital resource that can be used and reused to support learning.

---

[9] **David A. Wiley** is Chief Academic Officer of Lumen Learning, Education Fellow at Creative Commons. Wiley's work on open content, open educational resources, and informal online learning communities.

In order to catalog and define the syntax and semantics of the descriptive schemes of the LOs, numerous proposals have been put forward, but a complete and updated bibliography is missing; however, in the literature, models of taxonomic classification of teaching objects have also been proposed (Convertini et al., 2006; Redeker, 2003).

Among them, one of the best known was defined based on the identification of the different characteristics of LOs, such as the number of elements combined and the type of objects contained (Wiley, 2000).

This method identifies the following types of resources:

- **Fundamental**, for example images;
- **Combined-closed**, such as a text document with relative audio;
- **Combined-open**, for example a web page that contains a series of images and is built dynamically;
- **Generative-presentation**, for example a Java applet;
- **Generative-instructional**, for example educational software.

In the evaluation of digital cognitive artifacts and LO we will therefore find, therefore, to evaluate what is generally called "*educational software*".

For ***educational software***, as well summarized by Garavaglia[10], we mean an application program that contains educational contents organized according to a design oriented to the achievement of specific learning objectives in the various study disciplines.

However, as always Garavaglia specifies, more properly an educational software is a specific program for teaching the different disciplines of study.

[10] Andrea Garavaglia is associate professor in the grouping of pedagogy, at the Department of Human Sciences for Education R. Massa of the University of Milan-Bicocca and teaches Training Technologies and Methods and Techniques of Media Education. He is the technical-scientific coordinator of the LISP - Pedagogical Testing Information Laboratory and deals with the learning theme and new media with focus on learning environments, teaching methods, design and evaluation of training systems.

In consideration of this specificity for the evaluation of the quality of an educational software, it is necessary to consider not only the technical aspects, but also above all those aspects related to:

- **communication** methods
- **proposed** contents
- **possibility** to activate *significant learning* processes according to active and personalized modalities.

There are different ways and tools for an evaluation of the LO, but applicable, in general, to interactive and multimedia cognitive artifacts.

We will refer to the models:

- **LOEM** (**L**earning **O**bject **E**valuation **M**etric)
- **LORI** (**L**earning **O**bject **R**eview **I**nstrument)

The ***LOEM*** model was developed by Kay and Knaack in 2008[11] based on many of the instances considered positive by the previous models and focuses on five criteria:

- **interactivity;**
- **design;**
- **usability;**
- **engagement;**
- **content.**

The definition of the criteria underlies the explicit intention of the authors to favor the quality of constructivist activities where the user can sufficiently control the process and an adequate level of interactivity is assured.

According to the authors, a quality LO should ensure the opportunity to participate in open and rich activities and not to close the user in prescribed and closed learning paths (Brown, Voltz, 2005).

[11] Robin. H. Kay e Lieset Knaack, Faculty of Education, University of Ontario Institute of Technology, 2000 Simcoe St. North, Oshawa.

The quality categories used for the design concern the layout, the personalization, the quality of the graphics and the emphasis on key concepts.

Usability is measured based on ease of use, clarity of on-screen instructions and navigation.

Finally, the contents are evaluated based on the accuracy and integrity of the material presented.

Table no. IV.5. *LOEM model.*

Main criterion	Categories
Interactivity	*Approval questionnaire given to participants and possibly to other stakeholders.*
Design	*Recognition of knowledge, skills and objective intervention skills, before and after the intervention. Determination of progress achieved.*
Engagement	• *Difficulty level* • *Topics* • *Aesthetics* • *Feedback* • *Multimedialty*
Usability	• *Ease of use overall* • *Clarity of the instructions* • *Navigability*
Content	• *Accuracy* • *Quality*

The LOEM was tested by 33 faculty members of the Canadian first and second grade secondary school, submitting a large variety of LOs to 1113 students.

Although strongly contextualized to the school system, the study made it possible to identify the main criteria for the version presented here of the instrument and calculate a reliability index of 94-96%.

The validity analysis highlighted how the results of 4 of the 5 constructs used were in line with many of the previous evaluation tools to which the authors were inspired: the criteria that have received confirmation of their importance are interactivity, design, engagement and usability.

One of the most interesting aspects of Kay and Knaack's study concerns the predictive validity of the value of some interested dimensions; there was a high correlation between the performances in the survey of the learnings of the students and the levels of interactivity, design and at least a high level between engagement or usability.

Nesbit and Belfer proposed the **LORI** (**L**earning **O**bject **R**eview **I**nstrument) system in 2004.

The tool is divided into nine items treated with the same weight:

1. **Content Quality**: *truthfulness, accuracy, balanced presentation of ideas and appropriateness of levels of detail*;
2. **Learning Goal Alignments**: a*lignment between learning objectives, activities, assessments, and student characteristics;*
3. **Feedback and Adaptation**: *presence of adaptive content or feedback driven by the participant's differentiated input or his modeling;*
4. **Motivation**: *ability to motivate and stimulate the interest or curiosity of an identified population of students;*
5. **Presentation Design**: *design of visual and auditory information for greater learning and efficient mental processing;*
6. **Interaction Usability**: *ease of navigation, immediacy of the user interface, and quality of the "help interface" features;*
7. **Accessibility**: *level of support for students with disabilities;*
8. **Reusability**: *possibility to reuse the same didactic object among different courses or learning contexts without modifications;*
9. **Standards compliance**: *compliance with international standards and specifications.*

Krauss and Ally (2005) used a modified LORI (*Source: Adapted from Belfer, et al. (2002)*) It's Evaluation Criteria were:

- **Content Quality**: *veracity, accuracy, balanced presentation of ideas, and appropriate level of detail;*
- **Learning Goal Alignment**: *alignment among learning goals, activities, assessments, and learner characteristics;*

- **Feedback and Adaptation**: *adaptive content or feedback driven by differential learner input or learner modeling;*
- **Motivation**: *ability to motivate, and stimulate the interest of an identified population of learners;*
- **Presentation Design**: *design of visual and auditory information for enhanced learning and efficient mental processing;*
- **Interaction Usability**: *ease of navigation, predictability of the user interface, and the quality of the user interface help features;*
- **Reusability**: *ability to port between different courses or learning contexts without modification.*
- **Value of accompanying instructor guide**: *ability of resource to enhance instructional methodology.*

The ***LORI*** instrument was tested on a small population of adults (Krauss & Ally, 2005; Vargo et al., 2003), but unfortunately it was not possible to validate the instrument for all the specific criteria considered.

The tool has been the subject of several revisions, the latest being version 1.5.

For each item, the evaluation is expressed through a *Likert scale* of 5 modes, from **1 = Low** *to* **5 = High** and the choice **NA = not applicable**.

In both models and in general in the analysis of interactive and multimedia tools are elements to analyze accessibility and usability.

For accessibility, refer to the definition of "*accessible*" in the **WCAG**[12] (**W**eb **C**ontent **A**ccessibility **G**uidelines) 1.0 glossary: "*Content is accessible when it is used by someone with disability*".

Also interesting is the development of guidelines on the ergonomics of interfaces compared to the evaluation of cognitive artifacts.

---

[12] The Web Content Accessibility Guidelines (WCAG) are part of a set of Web site accessibility guidelines published by the Web Accessibility Initiative (WAI), which in turn is part of the World Wide Web Consortium (W3C). Content developers, development tools and accessibility assessment tools can follow these guidelines to create and evaluate accessible Web content, both for people with disabilities and for limited hardware or software such as mobile phones.

There is a strong activity in this sense by the **ISO** (**I**nternational **O**rganization for **S**tandardization).

ISO has promoted several proposals on the ergonomics of applications with reference to the accessibility of computer applications (ISO/TS 16071, "*Ergonomics of human -system interaction - Guidance on accessibility for human-computer interfaces*") and a new document on the ergonomics of Web interfaces (ISO / CD 23973, "*Software ergonomics for the World Wide Web user interfaces*").

For **usability,** there are two different standards in ISO:

- **ISO / IEC 9126**: *"Information technology - Software product evaluation - Quality characteristics and guidelines for their use"*
- **ISO 9241**: *"the degree to which a product can be used by particular users to achieve certain objectives with effectiveness, efficiency and satisfaction, in a specific context of use" (See Figure no. IV.8).*

It is therefore important to also have test tools, especially usability in which user satisfaction is understood.

For usability tests, for interfaces, we refer to the 10 Nielsen[13] heuristics.

They are called "heuristics" because they are broad rules of thumb and not specific usability guidelines.

- **Visibility of system status:** *the system should always keep users informed about what is going on, through appropriate feedback within reasonable time.*
- **Match between system and the real world**: *the system should speak the users' language, with words, phrases and concepts familiar to the user, rather than system-oriented terms. Follow real-world conventions, making information appear in a natural and logical order.*

[13] **Jacob Nielsen** is a writer, speaker and consultant. He holds a doctorate in the design of the user interface and computer science of the Danish Polytechnic. Nielsen worked in Bellcore, IBM, and as a senior researcher at Sun Microsystems.

- **User control and freedom**: *users often choose system functions by mistake and will need a clearly marked "**emergency exit**" to leave the unwanted state without having to go through an extended dialogue. Support undo and redo.*

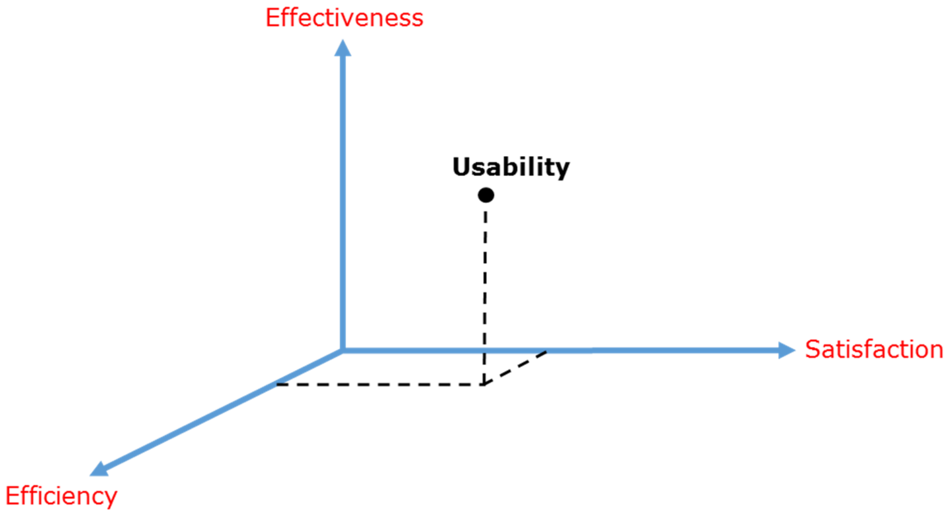


Figure no. IV.8. *Usability reference system.*

- **Consistency and standards**: *users should not have to wonder whether different words, situations, or actions mean the same thing. Follow platform conventions.*
- **Error prevention**: *even better than good error messages is a careful design, which prevents a problem from occurring in the first place. Either eliminate error-prone conditions or check for them and present users with a confirmation option before they commit to the action.*
- **Recognition rather than recall:** *minimize the user's memory load by making objects, actions, and options visible. The user should not have to remember information from one part of the dialogue to another. Instructions for use of the system should be visible or easily retrievable whenever appropriate.*
- **Flexibility and efficiency of use**: *accelerators — unseen by the novice user — may often speed up the interaction for the expert user such that*

the system can cater to both inexperienced and experienced users. Allow users to tailor frequent actions.

- **Aesthetic and minimalist design**: *dialogues should not contain information, which is irrelevant or rarely needed. Every extra unit of information in a dialogue competes with the relevant units of information and diminishes their relative visibility.*
- **Help users recognize, diagnose, and recover from errors**: *error messages should be expressed in plain language (no codes), precisely indicate the problem, and constructively suggest a solution.*
- **Help and documentation:** *even though it is better if the system can be used without documentation, it may be necessary to provide help and documentation. Any such information should be easy to search, focused on the user's task, list concrete steps to be carried out, and not be too large.*

In this context it is evident that the activity of instructional designers, and teachers, is very complex and can derive significant benefits from the availability of rich sources of information in which the necessary information so that we can select the most appropriate teaching resources are available compared to the characteristics of the training context in which it operates.

In this regard, even with undeniable differences, the most popular teaching design models appear to share the definition of four main phases:

- **design;**
- **realization;**
- **dispensing;**
- **monitoring/validation.**

During the first two phases focus on the definition of content and resources and there is the need to explicitly define different variables, such as:

- **target users;**
- **pedagogical-didactic objectives;**

- **knowledge domain;**
- **pedagogical model, strategies and teaching techniques derived from it;**
- **technological equipment and media formats supported;**
- **restrictions determined by use licenses;**
- **accessibility of materials.**

Information on the pedagogical model, strategies and teaching techniques are not represented in the descriptive models but must be inserted for a correct evaluation of cognitive artifacts.

From these reflections we note how despite the emergence of the web technologies of constructivist-social learning models, the models described above do not yet appear adequate to represent the social, collaborative and participatory dimension in the processes of knowledge construction.

The design and evaluation models have remained substantially anchored to a conception of the behavioral teaching contents and resources, which provides for a rigid transmission of contents from the teacher to the student.

From this reflection it follows that the definition of parameters must not only measure but also stimulate the design dimension correlated and inspired by the pedagogical model.

CHAPTER V.
Technology as a Factor to Improve Learning; Development of Learning Skills Through the Use of Instruments for the Structuring of Knowledge and the Detection of Data

V.1. Premise and context of research

V.1.1. General overview

The research that is structured and implemented has as its central theme the use of technology to support learning-teaching processes.

In particular, the central theme is how technological development strongly characterizes every section of people's lives.

Very often we notice the changes highlighting the problems that have generated or exalting the news. If technology enters the learning-teaching processes, it is certainly necessary to evaluate the problems and the potential to add value.

In summary, the central theme is therefore how to integrate a technology that is already permeating the lives of people, particularly young people.

Both the theoretical part and the practical part of this thesis work refers to a cone of technology as a treatise on an art, to see which are the logics that are implemented and induced by new technologies.

All this because no new technology has supplanted the previous ones but has integrated them and often incorporated them from a logical, even if functional, point of view.

For the world of education in formal, informal or non-formal environments, we want to reflect on how we can establish a virtuous circle that starts with teacher training for the design and implementation of effective and virtuous processes from a cognitive point of view.

The aim of the research is therefore to, starting from what are the "impressions" of how technology has influenced the teaching learning processes, to highlight what are the potentialities of technology in teaching.

The potentials that we seek to highlight start from the consideration of the perceived limits and risks, both real and hypothesized.

The technologies are too often seen from the perspective of a fashion, or a trend to which we must adhere, but it is not possible to imagine that there is a pure attractive effect of the technologies.

The reflection that guided the research is that technology must be considered from a functional "family" point of view to the students, so that overcoming a sort of instrumental obstacle we can exploit the increase of cognitive potential for effective learning.

The aim of the research is therefore, not binding on a specific technology that too often is identified with a hardware or software tool that is, to underline the possible improvement of teaching learning processes.

The research seeks to indicate a path for teacher training in the analysis and use of technologies and their use in training processes.

In particular, the aim is to underline the concepts of interaction, multimedia and logical connections as indicators of the formative effectiveness of a technology.

The ultimate practical goal is to ensure that the tools and technologies come in as educational tools in an organic way in the school to enable them to become more and more effective in their training.

In practice an attempt is made to ensure that the great stratification of information that the students must face turns into a learning model for content analysis for a continuous training and that includes all the years and environments that a person will find himself living .

V.1.2. The research

The research, which starts from the hypothesis and the social evidences of the use and influence of technology in everyday life, is articulated in 2 points that act as a cornerstone for reflections and the definition of practical interventions:

- ***technology has changed cognitive style*s and highlighted the limits and potential of the person-technology-knowledge relationship; this first part is developed through an exploratory research of the teachers' feelings in relation to the modification of the cognitive styles of their students;
- ***technology is an integral part of children's lives*** and they use technology as a privileged way of access to training, this second part is developed with the introduction of specific technologies in the didactic journey.

This new millennium, for didactic research, is an open construction site; a field of development and research that in these years presents a great variety of ideas and a ferment of innovation.

In all this set of ideas and processes it is possible to identify some fixed points that take into account the didactic research and teacher training, actors of the teaching-learning process; teachers who are not only called upon to define educational processes but also to make a decisive contribution to the definition and creation of cognitive, resources or technical device an integral part of learning.

The theoretical support is connected, albeit derived from the microteaching point of view, with Bruner's education theory, as it developed it from the early 1960s.

Kim Romney and Dwight Allen (Stanford University 1963) coined the term ***microteaching***.

Microteaching is born as a training practice for teachers and as a tool for pedagogical research.

Microteaching aims to provide teachers with elements for the analysis of their teaching practices, to have "the possibility of acquiring the techniques and skills necessary for the best possible performance of the profession" (Allen and Ryan, 1974, p.29) and also "considerably broadens the dimension of feedback" (ibidem, p.26).

It can be affirmed that, in this context, it is possible to make surveys of teachers' practices and artefacts in order to make them understand their meaning and objective during classroom work and individual study (Damiano, 2005).

It is a matter of taking up the concept of "stimulated recall" of the experience, in the perspective of an analysis of teaching practices that use resources or technical device.

Teaching practices that focus on reflections that are not "above" but "inside" teaching and educational processes.

Teaching that makes explicit the tacit thought of the teacher and is an expression of "**epistemology of practice**" as well defined by Donald Schön (1983), who also states, that develops the concept that according to the model of technical Rationality the professional activity consists in the instrumental solution of the problems rendered rigorous from the application of scientifically based theories and techniques.

This perspective defines research in education as a direction and focuses attention on the established broker processes.

Technology-mediated processes can be, for example, cultural devices or physical spaces; in this context, we will deal with aids and artifacts that arise between the actions of teachers and those of students of secondary school, thus acting as a reference framework for a didactic action consisting in the modulation and effective use of these elements.

The research in education, can be defined, in a clear and precise manner, as a systematic and rigorous investigation; a survey that aims to deepen, increase, or test the complex of knowledge, theories, documents, laws inherent to a given discipline.

The definition of the term research becomes the key with which data is analyzed, of the methodologies with which information is derived from the data, that is, the relationships that exist between the data are determined.

More and more the epistemological debate that is developing tends to highlight a dimension, a conception of research that shows, among others, as specific traits and inspiring motives the instinctive tendency to problems, a free exploration with traits of "*serendipity*" and with a focus on the complexity of the approaches.

By **serendipity**, we mean the ability to correctly detect and interpret a phenomenon occurring in a completely random way during a scientific research oriented towards other fields of investigation.

The logic of such a research emphasizes the profound relationship that exists between mental processes and the construction of the knowledge of the subjects and the processes that take place around the subjects; processes and phenomena that can be natural or social.

This first reflection highlights the impossibility of a design and consequent implementation and realization of a research project that starts from pre-definable results because the research feeds on the desire to test hypotheses, which may be wrong, in the continuous circle virtuoso of the search for models and realities that are increasingly suited to the analysis of the social, natural and internal processes of the individual.

A research therefore that works on the conviction that the mistake is a re-elaboration, in a scientific key of an aphorism of Rabindranath Tagore "If you close the door to all errors, even the truth will remain out of it".

When we talk about educational research, and in the field of pedagogy, we can apply a categorization that provides for the placement of research methods in two macro areas, i.e. qualitative methods and quantitative methods even if in literature we can use the two types of investigation using an integrated approach (Saukko, 2005).

The research intends to develop a survey and an evaluation of the effects of the use of integrated technologies in teaching-learning processes in relation to the survey of the situation and perceptions of the teachers of the lower secondary school.

We intend to assess whether indicators can be defined that evaluate the effectiveness and efficiency in relation to the cognitive processes of artefacts and technologies that allow the construction of learning artifacts.

The research intends to detect the incidence of technologies related to digital (interactive artifacts) and educational robotics tools and to define, if possible, indicators that can, in a preventive way, evaluate the didactic validity and then catalog standard tools and applications on a model which also refers to the "Pedagogical Wheel" (See Figure no. V.1.) and using the indications of the SAMR model.

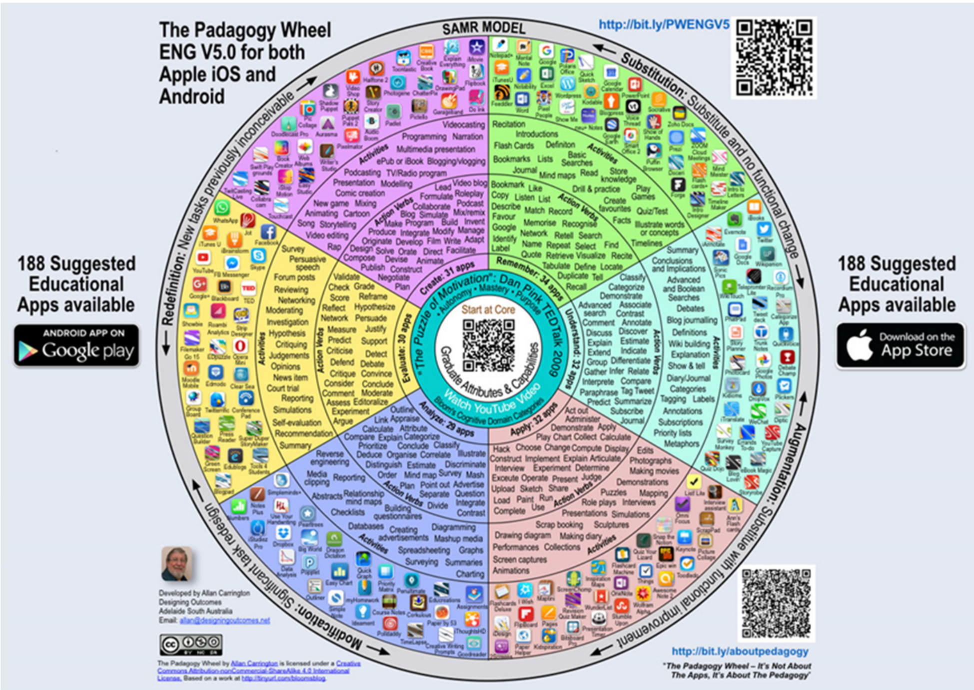


Figure no. V.1. Pedagogy Wheel (see https://designingoutcomes.com/english-speaking-world-v5-0_is in ***CC****, as highlighted in the lower left corner of the image).*

The Pedagogy Wheel, a crux between Pedagogy (the soul of the wheel, its raison d'être) and iPad, the first device for which it was adapted, can be defined as the "tool of the tools" for a digital school that puts the student at the center of his development path.

It is a tool that invites us to deeply be rethinking the whole learning process by incorporating technologies into a harmonious unitary mechanism, which considers the Bloom Taxonomy, the social and emotional learning, the SAMR model.

The **SAMR** model (**S**ubstitution, **A**ugmentation, **M**odification, **R**edefinition), is a theoretical framework of reference that aims to facilitate the integration of new technologies in teaching.

The Model is built around the idea that integration makes it possible to develop learning environments, manage tasks and build educational courses that are much more effective and completely new than traditional ones

The *research*[1] can be conceptually defined, in a clear and precise manner, as a systematic and rigorous investigation; a survey that aims to deepen, increase, or test the complex of knowledge, theories, documents, laws inherent to a given discipline.

The definition of the term research becomes the key with which data is analyzed, of the methodologies with which information is derived from the data, that is, the relationships that exist between the data are determined.

More and more the epistemological debate that is developing tends to highlight a dimension, a conception of research that shows, among others, as specific traits and inspiring motives the instinctive tendency to problems, a free exploration with traits of "*serendipity*"[2] and with a focus on the complexity of the approaches.

---

[1] R. Semeraro, National CODSE Conference Pedagogical, educational and training research in Italy (Rome, 17-19 November 2005), Research training in Doctoral Schools, in U. Margiotta (ed.). Pedagogical research in Italy, Mazzanti, Venice, 2007.

[2] The term serendipity, from Serendip ancient name of Sri Lanka is due to the writer Horace Walpole. The writer used this term in a letter of 1754 to Horace Manne and is inspired by the Persian fairy tale Three princes of Serendippo by Cristoforo Armeno, which tells of

The logic of such a research emphasizes the profound relationship that exists between mental processes and the construction of the knowledge of the subjects and the processes that take place around the subjects; processes and phenomena that can be natural or social.

This first reflection highlights the impossibility of a design and consequent implementation and realization of a research project that starts from pre-definable results because the research feeds on the desire to test hypotheses, which may be wrong, in the continuous circle virtuoso of the search for models and realities that are increasingly suited to the analysis of the social, natural and internal processes of the individual.

A research therefore that works on the conviction that the mistake is a re-elaboration, in a scientific key of an aphorism of Rabindranath Tagore "If you close the door to all errors, even the truth will remain out of it".

When we talk about educational research, and in the field of pedagogy, we can apply a categorization that provides for the placement of research methods in two macro areas, i.e. qualitative methods and quantitative methods even if in literature we can use the two types of investigation using an integrated approach (Saukko, 2005).

V.2. Research questions

Such a broad reflection and debate that is involving many disciplines, such as the pedagogical sciences, passing through engineering and psychology not only arouses interest but the need to question whether and how these technologies "interact" and "condition" the processes of teaching learning.

---

three principles that in their journey take on a series of information, not sought, that, will save them on several occasions. This origin determines the meaning of this term and that is the good fortune to make useful discoveries by pure chance and to find something that is not searched for and unforeseen while another was being sought.

It cannot be ignored that, although not in a systematic way, formal[3], non-informal[4] and informal learning[5] cannot be thought of without "technological" influences.

The focus of the interest of this work is certainly the formal, but aware that today more than ever the non-formal and the informal are part of the life of each and especially of the young people for whom many behaviors and cognitive styles are borrowed that technologies "*They suggest*".

From this overall image, object of many analyzes, observed from different points of view, a description of the BYO perspective is obtained.

This evolution of technology and trends in its use and methodological reflections lead educational technologies to a BYOD or BYOT design approach (Take your devices or Bring your technology), but with an interesting perspective BYOB (Bring Your Own Behavior), as analyzed by several authors who have addressed the use of technologies and learning in a digital world (Boldascio, 2015; Craig, 2018).

Research and experimentation in the development phase consider the fact that, while innovation derives from the interactivity of the tools, on the other hand it now has the benefit of interaction and connectivity, potential that must however be transparent with respect to the device used by the student.

BYOD or BYOT means, "*bring your device*" and it is a philosophy born in the company as a policy that aimed to make employees access company information using their PCs, smartphones and tablets.

---

[3] **Formal learning** is learning that takes place in an organized and structured context, in a scholastic or training institution in general, is explicitly designed and designed as learning and leads to some form of certification.

[4] **Non-formal learning** is learning related to planned activities but not explicitly designed as learning, such as that which is not provided by a training institution and does not normally result in an exam or certification test

[5] **Informal learning**: the multiple forms of learning through experience resulting from activities of daily life related to work, family, leisure, is not organized or structured and does not lead to certification.

This policy has not only an economic impact and security policies but also in the design phase, where the definition of tools is required to implement applications that can be used with the same potential in different user environments, both for the operating system and for device.

The BYOD born in a business environment with the main purpose of reducing costs has the undoubted advantage of allowing people to continue using a technological object that they know and use competently.

The BYOD logic in school and education in general, allows sharing the material and maintaining a continuum between the work in the classroom, at home and in any other place where data and information can be accessed.

Of course, both from a technological and methodological point of view, a BYOD approach can present pros and cons, but careful planning and structuring certainly allows us to make the most of the advantages that BYOD brings with it.

In particular, it can be noted that today successful mobile devices and services have two characteristics in common: they are intuitive and quick to use and if you do not understand how to complete a task in a few seconds, you search, download and try a other application; all this, in addition to exploiting the skills of students of secondary school, makes it possible to improve the user experience in the classroom

The fundamental questions that act as a plot and a watermark for research, and that arise from the reflections made so far can be summarized in 3 questions / reflections:

1. *How much technology has changed or influenced the cognitive styles of young people in general and of secondary school students in particular? If you use hardware and software technologies to structure the learned topics, and technologies that can experimentally detect data, does it increase the level of learning?*
2. *How much the use of integrated technologies in learning-teaching processes changes their development, and what are its advantages /*

disadvantages. Do the technologies introduced among teaching aids modify, and to what extent, the level of learning by modifying the modalities of information processing?

3. *How and how much the use of cognitive artifacts improves learning skills and allow secondary school students to acquire new skills. By incorporating physical tools and cognitive artefacts between didactic tools, transversal skills are increased, which make it possible to see technology as a competence applicable to every learning environment?*

With reference to the research questions, it is good to specify what is meant by some terms that characterize these questions.

Particularly when we talk about the relationship between technologies and cognitive styles, we refer to the problems related to the analysis of cognitive fields and cognitive modifiability.

Habits, in fact, are "cognitive paths" (Cussins A., 2002, pp. 651-658), experimental models of behavior with which we relate to the world, are learning patterns that presuppose visual points.

These paths outline the limits and potential of the cognitive field.

However, it is also true that they are likely to change, expand, interconnect, restructure or disappear with the activation of other fundamental knowledge.

In fact, the fundamental, basic knowledge that the school builds with its protagonists makes sense if all the subjects involved in the training game are aware that, while they build a knowledge, they activate a series of acquisitions that they will use, at least in part, in other contexts.

These are metacognitive learnings. When we talk about cognitive functions, we refer to basic cognitive and coordination processes.

Among the basic cognitive processes, we consider the following: perception, emotion, attention, memory, language (breadth and plurality of vocabularies, mastery and precision), and empathy.

Among the coordination ones, we consider the following: plurality of linguistic styles and interaction, visual-spatial and topographical

orientation, practicality and practicality, abstract thinking, intuition, creativity, cognitive self-awareness.

The use of technologies in learning-teaching processes must then verify how it affects teaching programming, and the objectives that can be measured and pursued in a more precise way, because the technology from a practical point of view allows tracking of activities of students and their analysis otherwise difficult if not impossible

By learning skills, the subject of the third question, we mean the problem-solving skills that the construction of cognitive artefacts be they pH detectors or conceptual map builders and time lines as in empirical research, which are identified in problem finding and in problem shaping.

In particular, the question is whether problem solving can be defined as a didactic approach aimed at developing, on a psychological, behavioral and operational level, the ability to solve problems.

Finally, the acquisition of new skills refers, in addition to the skills of analysis and synthesis, to those skills of structuring artifacts that can help in the processes of solving a problem, reusable skills in different areas and not just educational.

This produces a further question:

- *Can technology be integrated both as a teaching aid and as a tool for enhancing learning?*

To better identify and define what it means to ask yourself these three research questions that also represent a reflection in the field of educational research with respect to the field of study and investigation of this thesis, we define the purpose and objectives of each question.

The first question relates technologies and cognitive styles, focusing attention on secondary school students has:

- the **purpose** of understanding what, if any, is the influence of technologies, which pervade everyday life and pass through every phase of life, on cognitive styles; if and how they modify them;

- the **objective** is to identify keys of interpretation and tools that allow correcting distortions and using the potential to allow the boys to reach effective cognitive styles.

The consequent question, namely, to what extent the use of technologies integrated in the learning-teaching processes brings advantages and disadvantages has:

- the **purpose** of understanding if and how the use of technologies introduces changes in the design processes of teaching activities and changes the times and roles that students and teachers play in formal learning environments;
- the **objective** of defining methodologies and processes for the design and development of the learning path in formal training environments.

The last question relates instead to the use of artifacts by students and their construction in a perspective of learning contents through the ability to understand the data connections that generate knowledge.

This question related to artifacts has:

- the **purpose** of understanding the contribution of artifacts (both software and hardware) for improving learning, as an application of constructivist thinking;
- the **objective** of defining the types of artefacts that lead to an improvement in learning skills and the acquisition of skills; above all problem-solving skills, as we are analyzing in the context of educational robotics and it is interesting to see in the field of the machine learning.

V.3. Purpose and objectives of the research

In this context it can be said that we are talking about applied research because it is aimed at ***identifying practical solutions and in the specific context of formal learning***, and how technologies and cognitive devices are an aid to teaching-learning processes.

The primary objective is certainly not to progress in a theoretical knowledge but to make the theoretical knowledge related to the relationships "*fruitful*" for the development of tools that can be integrated in the technical field of the relative technology.

This research, from a theoretical point of view, also relies on Dewey's (1938) reflection on the problem between pure science and applied science, a reflection that can be summarized:

1. **knowledge** and **ideas** are the result of a method that was intelligently followed by the men who interacted with the environment;
2. **science** in a **technical sense** is a formalized processing of daily operations. Its meaning can be understood only by keeping in mind its relationship with attitudes and procedures that can be used by all people born with the ability to act intelligently;
3. **common sense** is relative and consists of both scientific attitudes and unscientific attitudes.

The purpose of analyzing and identifying the possible practical solutions for using cognitive artifacts, from the Apps to educational robotics, is certainly a vast research horizon that has a "reasonable" number of objectives in the work to be developed.

In summary 3 are the objectives of the research:

1. **test of a hypothesis**: 1. test of a hypothesis: the use of interactive technologies and cognitive artefacts as didactic tools allows increasing the level of learning; moreover, the use of technologies as a side effect makes it possible to generate collaboration processes (relational dynamics) in relation to the use of the technologies themselves.
2. **nomothetic[6] objective**: to define parameters that evaluate the didactic efficacy of cognate artefacts, also as an extension of the concept of learning objects and inclusive of educational robotics

[6] It is called **nomothetic**, the objective of every investigation aimed at the search for general laws and the formulation of theories including whole classes of cases.

methods and define the rules according to which these parameters can be used to categorize by use and effect cognitive artifacts.

3. **Methodological objective**: we intend to identify, starting from the cataloging of technologies such as that made by the pedagogical wheel, which are the types of technologies that can be integrated into the teaching process, both from the point of view of learning and from the point of view of the methods of teaching.

V.4. Research hypothesis

The research that has developed starts from the general assumption that technology is rooted and interconnected with the normal actions of people.

It starts from the general hypothesis that in everyday reality technology is a fundamental and characterizing part.

A technology, as reported by the 15th census of the Italian population made by **Istat**[7] (National Statistical Institute) is strongly rooted in the life of the Italian population.

Each family is equipped with devices and connections to the network, both "fixed" and portable tools, and this determines social and relational behaviors.

Technology has a strong influence on social, relational and economic dynamics, making its influence strongly felt on cognitive styles and approaches to the world around us.

---

[7] The National Statistical Institute (**Istat**) is an Italian public research institution. Its activities include:
- population censuses;
- censuses on industry, services and agriculture;
- sample surveys on families (consumption, labor, aspects of daily life, health, safety, leisure, family and use of time, etc.)

Istat is the official statistical producer supporting citizens and public decision-makers in Europe.social subjects.

These reflections that underline how the importance of technology and its overt influence on socio-economic-relational processes and cognitive styles can be summarized as follows:

- *Students through a conscious and purposeful use of technology can highlight how we can increase learning ability. How, from a structural point of view, imagine the technologies as an integral part of the students' growth path. The introduction of technologies both mediated by devices (software) and developed through applications hardware (for example electronic) in learning-teaching processes lead to an improvement in the level of learning. The level of learning has increased through improved technology-driven development of analytical and synthesis skills. This involves a research program that structurally incorporates technologies for the study, learning and communication of educational content.*

General hypothesis: *The use of technologies that develop interactivity, and present accessibility and usability characteristics in the integrated learning-teaching processes increases the level of learning, developing analytical and synthesis skills.*

Interactivity as an induced attitude stimulates the proactivity and participation of students in the processes of knowledge construction. Accessibility and usability as technologies-induced perception will activate, respectively the inclusion of the student, both from a relational and didactic point of view, and a perception of learning as positive. A positive perception not strictly functional attitude but as a relationship methodology with the world that surrounds us.

By level and ability to learn, we mean the mastery of knowledge in the disciplines, of languages and of appropriate tools, operational and research skills of information, analysis and synthesis skills.

The measure therefore also considers the extent to which the students can analyze and summarize the topics they face, the knowledge they are called to make their own.

The hypotheses lead to define the intervention program that works to integrate the technologies in the learning processes. Teaching in

a formal environment where interactivity, accessibility and usability lead to define more specific research hypotheses.

In particular, the general hypothesis can be declined:

1. with interactivity, the main advantage of digital tools, the level of proactivity and active participation of students in the teaching processes will be activated; *this first reflection leads to the hypothesis that the use of technologies and tools to structure, communicate and collect information, increases the level of learning and develops an effective system of relationships for an active participation in the construction of knowledge;*
2. with accessibility will intervene on the inclusion of each student, also from the point of view of the study tools; *we hypothesize the introduction of technologies that must be accessible reduces the difficulty in the use of teaching aids, and favors the development processes of individual skills;*
3. with usability, it will implement the endowment of learning with positive experience that leads to a continuous experience of endemic curiosity; *based on these reflections it is hypothesized that the use of measurable technologies in terms of satisfaction induces learning styles of the technologies themselves seen as transversal and non-functional tools linked to single action processes*.

From this general hypothesis derive two that specifically concern the formal training areas, to which we will dedicate the attention, but also informal and non-formal, which often represent the main environments in which the boys live:

- **technology** is a valid aid for learning and the perception of the world around us as a set of relationships; *the systematic introduction of technologies in the learning-teaching processes makes it possible to foresee that organic learning is obtained. A learning that knowing the logical structures of the learned knowledge makes it permanent in the students' baggage; thus, modifying the paradigms of learning models.*

- **technology** must aim to be more and more transparent towards the user, making it an accessible and usable way for knowledge; *the introduction of technology in learning-teaching processes allows us to observe a conscious use of technologies and their active integration in the continuous training processes that the students will face.*

For this reason, the research aims to ensure that through technologies, understood in a broad sense and not just "electronic", they allow students to make their own skills in analyzing and determining the logical networks that are the framework of all practical and abstract actions.

We intend to highlight how the multimedia and digital technologies have a real benefit, the interactivity that allows to enhance the capacities that allow an active learning.

The assumption of the research that is that the use of technologies, both in the form of cognitive artifacts, ready or to be built, and in the form of digital applications are an added value both in the learning process and in the process of "socialization" and development of skills for collaborative work.

These reflections and the research hypotheses that are made refer to secondary school students (*between 11 and 14 years of age*), and the related learning-teaching processes.

From this point of view, the general hypothesis is that technologies, due to their ability to generate interaction and their pervasiveness in the lives of children, are a privileged way forever more effective learning-teaching process.

It is not possible to ignore the social and technological environment in which children find themselves immersed in the planning of a learning path.

Two main secondary hypotheses are associated with this main hypothesis:

1. **tools and devices are transparent for secondary school students**; the ability that the students of secondary schools have gained to

use technological devices and content production methodologies with the use of technologies; the technological tool is not an obstacle and is not to be "learned" in the use of its basic functions; the use of technologies for the production of content, texts or audio-video, is part of the "experience" of the children starting, for example from a daily use of social networks;

2. **current use of devices has produced a more technological than functional development of the use of the technologies themselves**; the children know how to use the tools but do not perceive, consciously or unconsciously, their functionality, their potential, to transform this operational capacity into competence.

   In concrete terms two reflections can be made:

- students who normally use technologies will make targeted use of it, understanding its purpose and the structure of what they use;
- technological skills are transformed into cognitive abilities, knowing how to understand the use of a tool means understanding its logic and structure so this will facilitate an approach like knowledge and reality.

These reflections identify the following secondary hypotheses:

1. Interactivity of students with integrated technologies in teaching favors and increases the participation of students in training and the acquisition of knowledge
2. Accessibility of educational technologies promotes and improves the inclusive dimension of teaching processes by generating processes of information exchange and competences for students
3. The accessibility of didactic tools implements student satisfaction, giving an impulse to the "pleasure" of knowledge as an intrinsic enhancement of the person; also, in the absence of obvious and immediate practical or operational implications.

In formulating these hypotheses, it is also important to consider the concept of cognetics and cognitive and cognitive unconscious (Raskin, 2003) and the reflections that have emerged.

In this reflection it is good to keep in mind Marshall McLuhan's statement that the medium is the message, and that it is important to study the media not so much based on the contents they convey but based on the structural criteria with which they organize communication.

This attention leads to the concept of ergonomics, a science that deals with the interaction of the elements of a system, that is, to do something that has general characteristics that all human beings have in common.

Without these hypotheses, you would not have an ergonomic chair. Just as the physical constitution of a person does not change, in the main characteristics, from person to person, the same principle applies to considerations relating to the interaction between the individual and technology.

The term **cognetica** is introduced and well explained by Jef Raskin who states, "*Interface is on a human scale if it is sensitive to the needs of human beings and respectful of their fragility*".

It means, therefore, to create interfaces that not only know how to communicate but that they also know how to mitigate in some way the most frequent errors of humans; and this shifts the concept of customer-centered design software to a user-centered project.

This happens for two fundamental reasons: first, we move from the client-centered project where we think about market standards, to the communication interface, where we move on to the characteristics common to all men.

We therefore talk about the ergonomics of the mind and therefore cognitive or cognitive engineering, it is therefore stated that there are characteristics that all people share in their way of thinking when they relate to an artifact, or to a technology, through an interface.

The concept of ergonomics dates to 1871 and then resumed in 1949 by psychologists, but the idea is precisely to produce something that makes people work with less physical, then psychic and then cognitive effort.

Ergonomics thus becomes the study of what are called mental abilities that do not indicate who is intelligent, but of how the mind interacts with interfaces and through them to artifacts, that is an operational and engineering habit of structures, of knowledge and understanding of what that type of structure does.

The ergonomics of the mind starts from a concept, from a psychological question: what is the minimum effort to understand the functionality of an artifact? Idea associated with what in the 1960s was called **psychotechnics**, that is, people faced from the psychological point of view the machines they had to use at work according to cognitive paradigms.

Paradigms that lead to Human Information Processing, *i.e.* how to exploit the information that is assumed when a machine is to be used; in this case, for the interfaces of artifacts, we recall three principles that are typical of the **HIC** (**H**uman **I**nformation **P**rocess):

- **what is simple remains such**, if a process is automated it cannot be more complicated than it was previously; it is important to remember that the concept of simple comes relative processes composed of elementary actions; by elementary action we mean acts that cannot be further explained;
- **we must not damage the user's work**, it means that all the errors that the user can make must be governed in such a way as not to damage the work that the user himself has done;
- **do not waste the user's time**, which means affirming that with a minimum number of choices, mouse clicks, the subject must reach where he wants and, if the number of choices increases considerably, these choices must be relative to an action that it is strongly desired by the user, therefore not a simple but specific action. Making an equivalence between a mouse click and a choice it was said that every action had to be at most composed of three clicks.

In addition, of course all this reverberates on a design of the interface of artifacts that minimize the obstacles to their use.

The reflection on cognitive processes starts from the consideration that everyone has two cognitive modalities with which he interacts with artifacts and technologies in general: the cognitive conscious and the cognitive unconscious.

A limited number of properties characterizes these methods that both characterize them, and which are: activation, use, management, acceptance, operating mode, control, capacity and duration (see Table no. V.1.).

Starting from the assumption that all individuals do the actions either thinking of us or automatically, we clearly understand that when we think we activate the cognitive conscious, while the cognitive unconscious regulates all those actions we call "automatic" or "conditioned reflexes".

The cognitive conscious, therefore, is activated, when one thinks directly, in front of an emergency and danger novelty, if there is something that is not expected then one pays attention, in the new circumstances and in the management of decisions.

If we consider, for example, the reactions in front of a traffic light, the cognitive conscious is activated when there is orange that makes us think, it recalls the need for a decision: to pass or stop, a choice depending on the situation in which we find ourselves.

The analysis of the situation in which he finds us is a function of various elements such as the stop space, the distance from the vehicle that follows us and the choice of any vehicles ahead of us.

The cognitive conscious accepts only logical propositions, that is to say that only actions are taken which are considered logical and congruent in the context in which one finds oneself and has a sequential operating mode, in practice it has been shown that two or more actions are not carried out in a parallel way conscious; you can consciously perform only one action at a time.

The cognitive conscious is controlled by the will, has a minimum capacity, and can control one thing at a time and with an equally minimal duration.

If we relate the use of the cognitive conscious to our oral communication, we can manage it for a few tens of seconds, which is when we speak that we must be able to finish our concept in a maximum of about ten seconds to be able to manage the logical thread.

Table no. V.1. *Values of the characteristics of the cognitive conscious and the cognitive unconscious.*

CONSCIOUS (Conscious Cognitive)		**INCONSCIOUS (Inconscious Cognitive)**
News, emergency and Danger	**ATTENTION**	*Repetition, safety and expected events*
New circumstances	**USE**	*Routine*
Decisions	**MANAGEMENT**	*Operations without alternatives*
Logical propositions	**ACCEPTANCE**	*Logic or inconsistency*
Sequential	**OPERATIVE MODE**	*Concurrency*
Will	**CONTROL**	*Habits*
Minimal	**CAPACITY**	*Huge*
Minimum (tens of seconds)	**DURATION**	*Maximum (tens of years / life)*

The cognitive unconscious, on the other hand, comes into action when there is repetition, security and expected events, in routine, in operations without alternatives and accepts both logical and inconsistent predictions: An interesting feature of the cognitive unconscious is that it manages to manage actions simultaneously, for example in those who play the piano.

Furthermore, the cognitive unconscious is regulated by habits, has an enormous capacity, and a maximum duration, that is, it is possible to carry out actions and learn behaviors that are repeated even for years because they are things that you know and of which you retrieve knowledge and capacity immediately.

Interesting in this context of reflection on the relationship between man and technology, with a cognitive view, that it is possible to pass from

the unconscious to the cognitive conscious, to draw attention, but the opposite is not possible.

It is impossible to pass from the conscious to the cognitive unconscious and therefore it is not possible to make the user forget what he is doing if not bringing to the conscious something else, therefore, attracting the attention of the user and distracting him on a another thing, an important consideration in the design of artefacts that facilitate their use with a view to inclusion.

This brief reflection explains why technology focuses on the terms of accessibility and usability.

Usability means the **effectiveness**, **efficiency**, and **satisfaction** with which users achieve certain objectives in certain environments (**ISO** - **I**nternational **S**tandard **O**rganization - 9241, Ergonomic requirements for office work with visual display, Part 11).

Efficiency is means that users can achieve the goal, for *efficiency* that users are able to operate in optimal times and to the ***satisfaction*** that users are happy with what they do, without stress.

Accessibility means the ability to ensure that services, such as web access, are available to people as widely as possible regardless of whether or not there are impairments of whatever nature they are which is not an issue of handicap, but it is not being obliged to have specific capacity tools; that is, the idea is to make sure that the causes of the problems are not analyzed but the possible problems and their solutions.

This attention is to make usable artifacts and machines to the people for whom they were designed and for all those who should benefit from them.

Awareness of these processes and the integration of technologies would also make it possible to integrate the lesson into a learning flow that technologies are "spreading" in formal, informal and non-formal learning environments.

The lesson would thus become not only an opportunity for learning with the help of technologies, but also for learning about technologies and education for their correct and effective use.

The feeling is that, while there is a strong and constant focus on all the issues related to technology addictions, the “daily” use of technologies can have its finalization and its valorization in the insertion in a training path, especially in the formal learning context.

It is hypothesized that a use aimed at learning as well as giving a benefit to the teaching-learning processes present the side effect of re-contextualization of “technological” abilities that the children assume.

A virtuous process can be generated that can be summarized in the efficacy of a process that emerged in research and experimentation as the correct use of tools in educational contexts: an **AUM** process (**A***pproach,* **U***se and* **M***etabolization*).

A path that has a first phase approach, in which you are familiar with the tool to learn about the functions, a second phase, use, when using the tool to achieve the required objectives, and a third, an evolution of the previous phases, metabolism, in which the instrument becomes a “competence” of the student and used to access content and activities for learning or verification.

At this point, we can begin to stop thinking in terms of experimentation, but in terms of using the technological potential, with reference to interactive and multimedia skills, in the teaching-learning process.

A final hypothesis is that a determining factor in the integration of multimedia objects, cognitive artifacts, and their effectiveness is the level of interactivity they entail.

Levels of interactivity that can be measured and categorized using two definition systems:

1. Jens Jensen, Interactivity: interactivity as a “measure of a medium's potential ability to let the user exert an influence on the content and/or form of mediated communication”.

2. Brenda Laurel, Computer as Theater, identifies three fundamental variables in the composition of the interactive effect:
   2.1. **frequency** (how often it is possible to interact)
   2.2. **range of variability** (how many choices are available)
   2.3. **relief** (how much the choices affect the problems)

The independent variable will be controlled directly by the experimenter, assigning the subjects to the different groups and each group will be associated with an independent variable level.

The hypothesis includes an intervention program that foresees the introduction of technologies in teaching processes, the use of technologies in the scientific area and in the humanities area.

The intervention plans to have an experimental group that will use mediated technologies (software) to formalize and communicate the contents presented in the historical-social-scientific field.

The use of technology is expected with hardware sensors to understand and measure the acidity and basicity of liquids (pH).

The research intervention program starts from the study and participation in experiences of teacher training and experimentation in educational robotics.

The experience of training teachers and future teachers has put me in contact not only with the need to teach the possible use of technologies in educational activities but also in front of requests for further information coming from the real school, from those who confronted each other day after day with guys.

V.5. Research variables

How it was defined, the general hypothesis is that technologies, due to their ability to generate interaction and their pervasiveness in the lives of children, are a privileged way forever more effective learning-teaching process.

From the main hypothesis it is expected that there may be two side effects that are detectable in students' practices:

1. **tools and devices are transparent for secondary school students**
2. **current use of devices has produced a more technological than functional development of the use of the technologies themselves**

To define which variables are measured, considering the hypotheses formulated, refer to the classic definition whereby:

1. **independent variables**: the factors that the experimenter manipulates;
2. **dependent variables**: the variables that are measured in the experiment.

The use of these variables is from observations and preliminary research on the modification of learning styles is significantly related to the hypotheses.

It is hypothesized that the use of devices and technologies that permeate children's daily lives is an excellent vehicle to improve their level of learning.

In particular, the use of these devices and of production technologies and use of content must also be used to metabolize and transform these abilities into skills.

From the research point of view and with these reflections, the level of learning is a factor that the researcher manipulates, as it tends to increase it by using devices and technologies that are supposed to be the keystone, as they are the heritage of experience and experience of boys but are used to finalize learning.

A learning that tends to make people understand the schema of knowledge, a scheme and a competence that having available, through the web, information at any time, has lost. Similarly, as the mnemonic capacity changes or changes when we know we have supports that can complement or replace it.

The independent variables that the intervention program, using software and hardware technologies (educational robotics) can be listed do:

1. *level of learning of the contents*, using an evaluation scale, in relation to the objectives of the learning teaching process;
2. *level of metabolization of the processes* of use of technologies such as "competence" by evaluating during the observation phase and the questionnaires, transforming them into a value scale.

In relation to the independent variables, the intervention plan to:

- *level of learning of the contents*: the collection of assessments, the level of understanding of the contents before the use of the technologies and then after the use of the technologies. Knowledge assessment and verification systems are the tests that normally each teacher periodically administers to their students; tests that you notice among students as "interrogations" and "classroom tasks"
- *level of metabolization of the processes of use of technologies*: the use of evaluation questionnaires that assess the perception of tools and technologies by students and of both functional and cognitive problem-solving processes that they induce.

The measured dependent variables (see Table no V.2) will cover three areas:

1. The level of **interactivity** of the technologies used**,** to be understood as the measure of a medium's potential ability to let the user exert an influence on the content and on the form of mediated communication (Laurel, 1993); an interactivity that can be seen divided into the types:
    a. *Selection of contents*
    b. *Modification of contents*
    c. *Social sharing*
    d. *Affirmation of identity*

2. **Accessibility**, intended as a characteristic of a device, a service, a resource or an environment to be easily accessible by any type of user; in this context, we could speak more precisely of usability. Usability in the **ISO** (**I***nternational* **O***rganization for* **S***tandardization*) definition, such as the effectiveness, efficiency and satisfaction with which certain users achieve certain objectives in specific contexts. In practice, it defines the degree of ease and satisfaction with which the interaction between man and an instrument takes place.
3. **Usability**, understood as defined by the **ISO** (**I**nternational **O**rganization for **S**tandardization), and that is effectiveness, efficiency and satisfaction with which certain users achieve certain objectives in specific contexts. In practice, it defines the degree of ease and satisfaction with which the interaction between man and an instrument takes place. The term does not refer to an intrinsic characteristic of the instrument, but to the process of interaction between classes of users, product and purpose.

The measurement of dependent variables aims to verify the effectiveness of teaching methods and technologies, reflecting on how interactivity, usability and accessibility of the technologies used, are ultimately the factors on which to operate to effectively integrate tools and methodologies to support learning, with software for generating interactive and multimedia objects, as well as educational robotics tools.

Understanding with multimedia a form of communication characterized by the coexistence and interaction of multiple languages and tools, both virtual and real.

In other words, there is a strong influence of these codified, measured and verified dependent variables (Laurel, 1993) and the effectiveness of the methods and technologies applied to teaching that have significant values of these variables (Cantoni, et al. 2003; Krug , 2000).

Table no. V.2. Dependent variables and methodological references.

#	Dependent variables	Research methods	Researcher tool	Researcher tool's characteristics
1	**Interactivity: technologies:** **Frequency** (how often you can interact) **Range of variability** (how many choices are available) **Relie**f (how choices affect problems)	Experimental	Test to detect the level of interactivity	Taken from literature (Laurel, 1993)
2	**Accessibility of technologies**	Experimental	Test	W3C standard test, WCAG project
3	**Usability of technologies**	Experimental	Empirical and inspection tests	Taken from literature (Cantoni, et al. 2003; Krug,2000)

In Table V.2. there is the elimination of the dependent variables that must be understood, from a practical point of view:

- ***interactivity***: the level and capacity of a system to exchange information with the user and to configure processes that are logically dependent on the information entered and the processes activated;
- ***accessibility***: the feature that determines the ability of a device, a resource, a system or an environment to be easily usable by any type of user or by the user to whom it is directed. That is to say that accessibility is the characteristic that makes it possible also for persons with reduced or inadequate sensory, motor, psychic or cognitive capacity, both temporary and permanent, to use and access independently even with the use of assistive technologies;
- ***usability***: it has a codified definition by the ISO (International Organization for Standardization), such as the effectiveness, efficiency and satisfaction with which certain users achieve certain objectives in specific contexts. In practice it defines the degree of ease and satisfaction with which the interaction between man and an instrument is accomplished (console, gear lever, graphic interface, etc.); the term does not refer to an intrinsic characteristic

of the instrument, but to the process of interaction between classes of users, product and purpose.

We also refer to the different heuristics.

Interactivity using Brenda Laurel's scheme, integrating measurement scales with Jens Jense's concepts.

For accessibility, reference will be made to Cantoni's empirical and inspection tests[8].

The tests and tools for research are used according to the structure provided by the literature, since it is important to fit into the standard processes of technology assessment.

To this, it must be added that the vast experimentation carried out in these years both by W3C and by important Universities represent an excellent validation of these instruments.

These tests follow the schemes present in the annexes (A.6).

During the experimentation, the measurement of the dependent and independent variables was made through the standard detection tools (See Table No. V.2), tests that measure on the one hand the effective effectiveness of the use of technologies and on the other the influence they have on educational dynamics, as described above.

The measure of interactivity has been flanked (with observation and test tools) to the extent of student participation in the construction of knowledge, in terms of quantity of information retrieved and shared with other students.

The measure of accessibility, always according to the canons and tools listed in Table no. V.2, saw through observations and questionnaires (on the difficulties of use) the measurement of the inclusive capacity of technologies and the generation of a system of learning communities.

Similarly, usability was measured with validated tools (see Table No. V.2) and the satisfaction in the use of technologies in terms of "pleasure" was measured through evaluation questionnaires (with the

[8] See Cantoni, L., Di Blas, N., Bolchini, D. (2003). Communication quality, usability. Milan: Apogeo.

measurement of attitudes) of knowledge and "satisfaction" in learning even without immediate practical returns.

The variables of interactivity, usability and accessibility are measured independently from the type of device, only in relation to functionality and relative cognition

A measurement instead of the level of learning was made with the use of verification tests, which made it possible to relate the results obtained with the previous assessments; the assessments that measured the level of learning are compared with the assessments of the control group and these measures analyzed and interpreted with Cronbach's Alpha.

V.6. Sample of subjects

The research will have as a sample 6 middle school classes and 3 classes as a control sample.

The sample consists of 182 students and 54 students in the control group, all student is of secondary schools.

Instead, the teachers' perception analysis phase is based on a sample of 182 area and training professors.

The scientific area and the humanistic area were divided for both training and teaching.

We also intend to evaluate the fact that the students of secondary schools of the control group are not divorced from the technology they also use to study and in schools, even though using a simple LIM[9], almost all students of secondary schools have experimented with technologies in their learning teaching processes.

[9] The **LIM** (**L**avagna **I**nterattiva **M**ultimediale - Multimedia Interactive Whiteboard) is an interactive surface on which it is possible Cantoni, L. , Di Blas, N., Bolchini, D. (2003). Comunicazione qualità, usabilità. Milano: Apogeo to write, draw, attach images, display texts, reproduce videos or animations.

The structure of the groups that have been the object of analysis, research and the control group reflect what are the numerical relationships with respect to the sex of the subjects, of their training (in the case of teachers) and of the training path about the students of secondary schools.

The teachers of the preventive analysis are 182, 36 male, and 165 female and 3 who do not respond (see Figure no. 2.V.).

The research focused on secondary school students because I considered, based also on OECD surveys that it was appropriate to start from this phase of education to identify a process that starts from teacher training to the use of technologies in teaching and then start with the first training cycles.

The continuous and integrated use of technologies is not a response to a didactic fashion but to a complex analysis of society that offers tools and areas that cannot be ignored in formal training environments.

We chose a school that had available technological resources and environments in which to experiment; in fact, this has also introduced the complex discourse of the relationship between training environments (classes) or better the environments as an important element of the learning-teaching process.

The chosen school, a secondary school of secondary school (middle school) had, besides technical-environmental characteristics, a uniformity of the teaching body and divided into two separate complexes.

Having a homogeneous teaching body allowed us to suppose a didactic approach homogeneous to the two groups, experimental and control, and to be the school divided into two different places guaranteed less influence and interconnection between the students of the two groups, the experimental and the control.

In one complex, the one with the best didactic equipment and in which there are 4 sections for 12 classes, 50% of the classes were chosen as well as for the control group; in fact, in the complex in which the three classes were chosen the sections were 2 for a total of 12 classes.

From an analysis made with the teachers both from the point of view of the performance and from the point of view of group dynamics the classes presented the same characteristics.

Both in percentage and in quality the distribution of returns was homogeneous, to respect a Gaussian distribution.

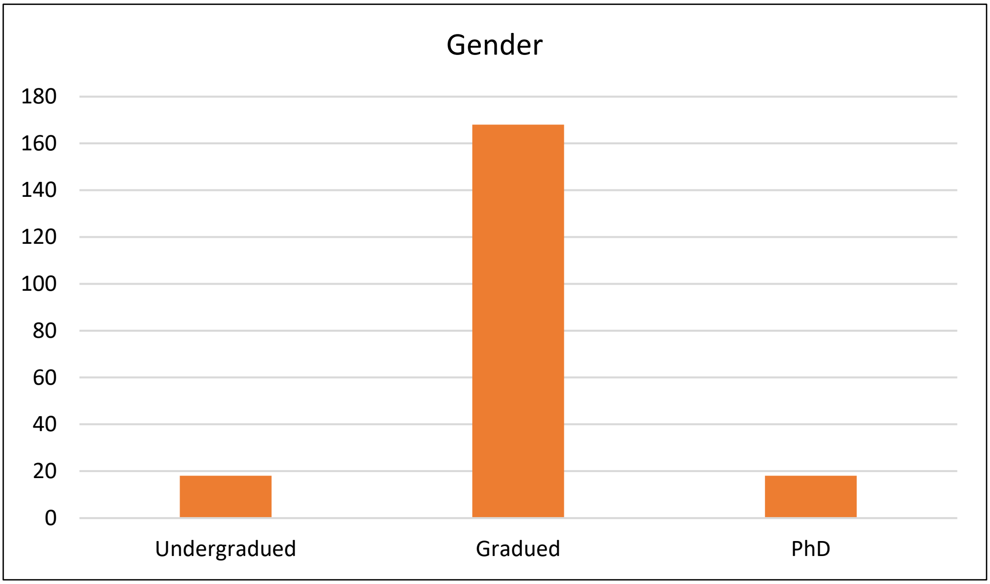


Figure no. V.2. *Teachers divided by gender.*

Also, from the point of view of interpersonal relationships the classes appeared homogeneous with some element more isolated and with some element that focused attention and could be defined as opinion leader.

The research took place in a strongly similar environment for the control and experimental groups and even though the research focused on a "good" environment, it allowed to reason and highlight on parameters, methodologies and didactic planning.

These the level of education is of 18 graduates, 168 graduates and 18 with PhD, that respect the national averages of the teachers in Italy; in terms of representation (see Figure no. V.3.).

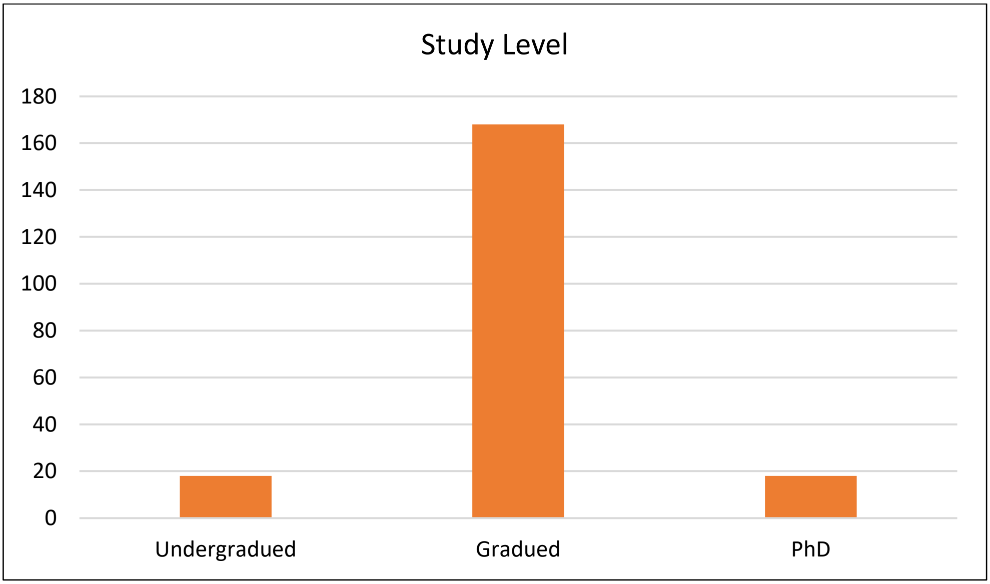


Figure no. V.3. Teachers divided by study level.

As for the students of secondary schools, the experimental group took six classes, two for each middle school class with a gender breakdown as shown in the Figure no. V.4.

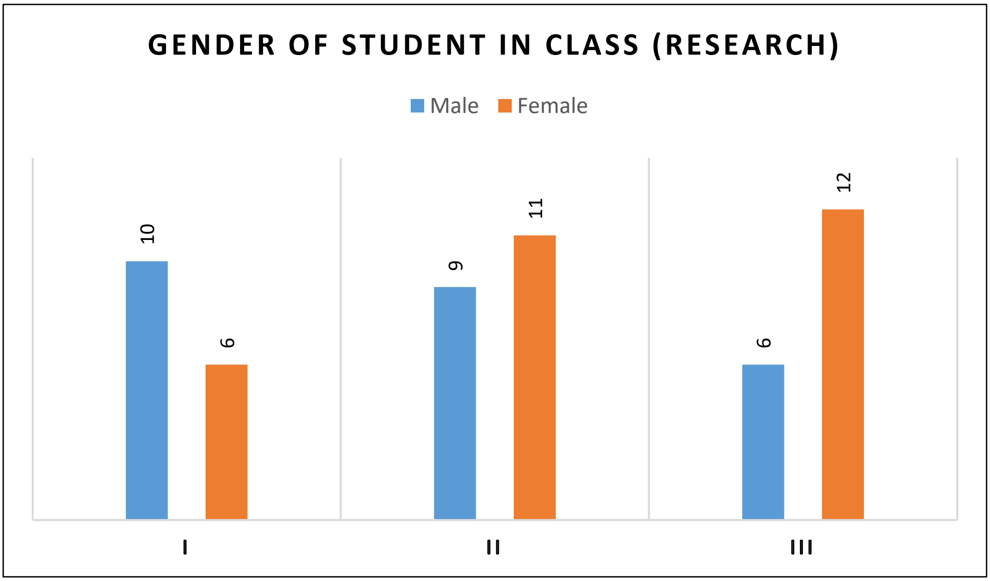


Figure no. V.4. Student, research group, divided by gender.

Similarly, for the control group we have represented distribution in Figure no. V.5.

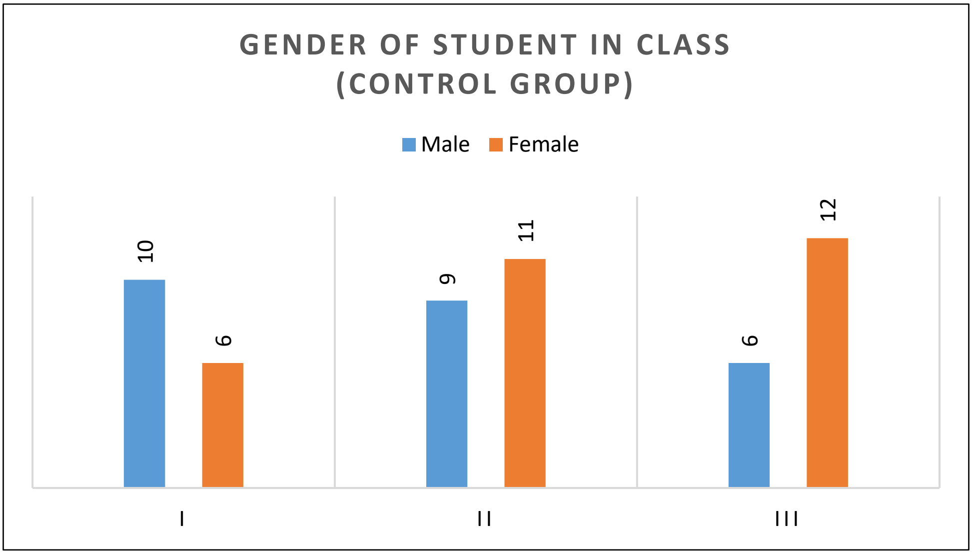


Figure no. V.5. *Student, control group, divided by gender.*

V.7. Place, period and methods of conducting research

The experimentation takes place directly in the schools and covers a time span of 3 months in school year 2018, since the scholastic needs, the curricular activities and the management do not allow currently a different time and method.

It was decided to work with middle school classes, placed in complexes of the city.

Classes, as well as schools, present children who come from different social situations, even if an area of hardship is not relevant and, they did not present situations of learning difficulties; there were no stated learning difficulties.

The schools have characteristics that can be found in almost all Italian schools that have been standardized by the different national projects.

Note the presence of computer labs and **LIM** (**L***avagna* **I***nterattiva* **M***ultimediale* - **M***ultimedia* **I***nteractive* **W***hiteboard*) present in the classroom.

Regarding educational characteristics and objectives, as well as the final exam, they are homogeneous throughout the national territory.

The middle school is included in the compulsory training cycle for all Italian children.

There are basically two methods used in the research

Observation through the questionnaires provided to the teachers for the observation of cognitive styles and in the post-experimental phase to the teachers of the experimental and control groups for an evaluation of the modification or not of cognitive styles, learning and socialization.

Experimentation phase in the application of interactive and multimedia technologies to teaching, defining the scope of intervention, trying to "manipulate" the learning, metabolizing factor of technologies to make them competent, and measuring the learning and communication results of the acquired knowledge.

V.8. Research methodology

Before analyzing the characteristics of the research methodologies, it should be said that the research made use of tests and questionnaires and a statistical analysis of the data.

The tests and questionnaires were used to detect:

- attitudes and behaviors of students in their interaction with technologies;
- problems with the use and understanding of and solution methods used by students;

- verification of the level of understanding and learning of the topics introduced.

The collection and analysis of statistical data was used in terms of:

- **frequency**: absolute frequency was used to understand the dominant characteristics in the fields of analysis
- **percentages**: to understand the incidence of certain attitudes and learning outcomes of the didactic intervention
- **Cronbach's alpha**: to measure its reliability, or to verify the reproducibility over time of the intervention, under equal conditions, of the results obtained.

V.8.1. Quantitative Research

The research can be defined quantitative is characterized by a low degree of interaction with the subjects involved to have a consequent lower risk of data contamination by the researcher.

Furthermore, the research is characterized by the quantitative analysis is the formalism of the procedures: the collection, the data processing, the use of the data matrix and the use of statistics follow defined and easily replicable protocols.

Although in the educational field, it is easy to imagine that replicability is subject to factors that change over time, the cultural background of students of secondary schools and teachers and the socio-cultural situation.

The high formalization allows the researcher to detect and store a large amount of information with highly standardized tools.

Since we intend to look for explanations of the values assumed by the dependent variables on the basis of the values assumed by the independent variables, identifying relationships, not necessarily causal, between the variables themselves we will use the standard search, research

based on the data matrix, descends from the tradition of quantitative research, which has its precursors in Galton, Wundt and Thorndike.

The name recalls the characteristic of this research strategy to have highly formalized phases and procedures.

Its high degree of formalization makes it in many ways simpler than other search strategies.

V.8.2. Research by Experiment

Since among the objectives of the research, there is also the objective of identifying causal relations between factors, or relationships in which it is assumed that a supposedly dependent factor is properly caused by (at least) another supposedly independent factor we will also use the research methodology by experiment.

The research methodology can be classified according to different parameters; a classification criterion for scientific research methods is essentially based on:

- **possibility** (degree) **of control** that the researcher has on the situation in which the phenomenon under study is manifested;
- **possibility** of minimizing the effects of disturbance (constraint level);

With this approach, we can speak of degree of control:

- **maximum**: when the researcher himself "produces" the phenomenon (i.e. in the laboratory);
- **minimum**: when the nature of the phenomenon is such that it can be observed only in conditions that the researcher cannot influence in any way.

The constraint level can also be considered and defined:

- **high constraints**: high degree of constraints imposed by the researcher;
- **low constraints**: minimum or zero degree of constraints.

In this structural panorama, during the research phases an experimental method was used, which normally guarantees maximum internal validity, which with structural validity is the best verifiable in this field of research.

V.9. Research phases

V.9.1. Pre-experimental phase

This phase that started the journey of research has had as its focus the need to understand if the needs and the questions that were asked by the scorers were the result of a reality or if it was the indicator of a "*problem*" that permeated the school.

For this reason, a questionnaire was created in which assertions were gathered from the meeting with the teachers in different realities, both formative and within the network of schools that experimented with the use of educational robotics.

This questionnaire was then submitted via the network to the teachers of the middle school, on the national territory.

The choice of middle school teachers was the fruit of a part of the choice of the type of school on which to do then experimentation, but also because the middle school is the first cycle in which the students have a disciplinary approach with the study, where in the school elementary lived a more globalizing reality.

The aim was therefore to understand if the impressions and the evolution of the cognitive styles of the boys as they were observed by the teachers.

In the pre-experimental phase, an exploratory research is carried out as regards the "sensations" of the teachers on the use of technologies, in parallel with a survey of what are the real availability and types of technologies available.

As part of the research activities, it was also considered necessary to start a study on the effects of the use of technologies in processes on training practices and on their models, also considering the consequences, which are not always explicit, that both have regarding of behaviors and values.

It began with a first exploratory research; it is in the proposal of a school that aims to enhance the talents of both teachers and students of secondary schools.

It was intended to develop starting from an analysis of the situation and perceptions of the teachers of the first level secondary school strategies and procedures that can orient the cognitive habits of children and adolescents differently.

V.9.2. Experiment phase

The experimental phase is the heart of the intervention within the school and work has been done so that the conditions of the normal learning path could be reproduced.

The choice of the school and the activities to be carried out was dictated by two factors:

- the school had equipment and technologies;
- the school has two locations where the influence between the control groups and the sample group has been minimized and a homogeneous teaching group.

What we wanted to achieve was on the one hand the use of network technologies that implement logic and tools common to many of the software and virtual places frequented by students and on the other the use of “hardware” technologies to allow also instantiate, make the logic logical and understandable; it was intended to make a real virtual exchange to give concreteness and to highlight the common logics that govern the technologies that can be traced back to the same logical

prototype of knowledge, the network, the graph where meaning is given by relationships and can be represented in different ways the same structure.

At this stage, methods were pursued to induce young people to develop problem-solving skills, to learn from errors and to understand the points of contact and the common logic between information systems and the logic of learning, sharing and using the know.

The experimental phase will develop through interventions that will be divided into two types:

- use of online applications to approach and communicate historical topics in parallel with social and scientific events
- creation of cognitive artefacts, educational robotics, to understand the meaning of a scientific concept through data collection, the concept of acid and basic

Starting from these two lines of experimentation, two interventions were made, the first aimed at using an interactive multimedia tool, which allows the creation of different multimedia tools in order to communicate contents related to the succession of historical, social and scientific events.

The second experiment focused on the use of simple electronic artifacts for data collection and a consequent explanation and communication of the chemical concept of acid and basic.

The topics, although not integrated in the specific program of all the courses, the classes, for a total of 6 were 2 for each of the 3 years of the middle school represented a deepening.

The pedagogical intervention to support and found the research is based on a problem-based method, the pedagogical approach centered on the student who uses the analysis of a given problem as a starting point for the acquisition of new knowledge.

After an introduction and explanation of the topics, the students were guided and actively encouraged to reason and solve the problem.

The problem, which for the part related to the humanities area, was identified with communicating and explaining the relationships between social events and scientific discoveries, obtaining and drawing independently on all the information sources necessary for this purpose.

For the scientific part, the problem was to measure the pH of liquids using the appropriate tools, after having understood the meaning and the methods of identification.

The implementation of this pedagogical intervention prefigured to obtain two closely connected results:

- **a better level of learning** *(a better cognitive performance)*
- **a structured learning**, that is, the knowledge became known in its logical fabric allowing it not a mnemonic but effective and continuously expanding knowledge.

V.9.3. Post-experimental phase

The post-experimental phase is concerned with verifying whether technologies have actually induced better learning results.

To make this phase as significant as possible, both the topics covered and the verification methods reflected the training path, taking into consideration topics that deepen the students' knowledge.

In particular it was decided, speaking with the body to tackle two problems, one of a scientific nature, to test the effectiveness of physical tools that implement logic and one of a historical nature to see how technologies can be of help for the development of skills analysis and synthesis.

The main purpose of using a software for the creation of multimedia documents was to ensure that in order to “automate” knowledge, the relationships between the historical, social and scientific events of a historical period should be discovered, with the aim also of communicate this logical network.

The use of electronic technologies is instead functional to the understanding of technologies according to the logic of implementation

and the purposes of use, ensuring that problem-solving skills were promoted that led to the discovery of error as learning.

The evidence of this potential of technologies is the result of a comparison with those who, the control group, continued to have sequential tools and little stimulate reticula structure, the logical basis of all learning processes as also developed by artificial intelligence engines , which use neural networks.

Evaluation of the minimum objectives of knowledge that the teaching modules proposed, analysis of the data and research of the correlations and of the meaning they assume in the research project.

Analysis of the data relating to the dependent and independent variables according to the scheme correctness and truthfulness of the conclusions reached through an empirical investigation.

Cook and Campbell (1979) distinguished 5 types of validity:

1. **Internal validity**: can the results of a research be attributed to independent variables? can conclusions be drawn about the causal effects of the independent variables on the dependent variables? Its assessment consists in examining, and discarding because logically implausible, alternative interpretations of the relationship between variables.
2. **Construct validity**: correspondence between theoretical concepts and empirical operations. The translation of the concepts into attributes of the units of analysis, the logical relationship between the construct, the concept, and the experimental variable that represents it.
3. **External validity**: possibility of generalizing the results of the sample to the target population, to populations, environments and times different from those in which the research was conducted.
4. **Ecological validity**: the results can be generalized to environments other than the one in which the research was conducted. A search has ecological validity when the context in which the search is performed is representative of a real context.

5. **Statistical validity**: application of statistical techniques to verify the existence of a relationship between two or more variables in the population from which the sample is taken. The statistical validity concerns the probability that the relationship between the variables is effective, not due to chance.

V.10. Tools used in research

In relation to the methodologies identified, they will be used as tools:

1. *Test, for verification of acquisition of knowledge and skills*: at the end of the learning path, learning verification tests were used. In particular, the theme tool and closed and open questions were used to ascertain the skills acquired;
2. *Questionnaires* (multi-item scale and **Likert scale**): the questionnaires used were used on the one hand to take information and on the other to verify attitudes. The survey questionnaires had questions, for example, relating to the devices owned by the children (see Annex A.2); the questionnaires used to detect attitudes demanded the level of acceptance of statements;
3. *Observation form*: the teachers to describe (in a completely unstructured way) the attitudes of socialization and attention that the children expressed compiled the observation forms.

In particular, the research tools have focused on the possibility of detecting a part of the level of learning achieved, hypothesizing that the use of technologies increases the level of learning in relation to the topics treated but developing structured learning skills.

The tests for the verification of competences used open questions that asked to describe an aspect of the topics treated and evaluated in relation to the ability to describe the specific topic correlating it with the underlying concepts or dependent events.

Tools for generating semantic clouds[10] (or clouds of labels or word clouds) were also used to highlight the key words and the logical relationships of the texts produced by the boys.

Equally important were the questionnaires (with Likert scales) administered in timeframes compatible with the use of technologies to verify the attitudes arising in boys.

These questionnaires (see Annex A.2) were aimed at detecting what attitude had arisen in the boys towards technology and their use in the didactic journey, but also the attitudes and behaviors induced in the relational system of the class, to measure also the side effects of inclusion in the educational path, mediated by technology.

In addition, the observation modules of the teachers who allowed, with open questions to describe the "relational" trend and the attitude towards learning, were the source of generation of semantic clouds to understand if the didactic intervention produced the prefigured results.

Semantic clouds, like text analysis, allow the identification of keywords, and logical proximity of expressed concepts, key words and logical proximity that represent significant indicators of the results achieved and detected.

V.11. Intervention program

Introducing the intervention program, we remind you that the dependent variables referred to are those identified above:

1. ***content learning level***, using an evaluation scale, in relation to the objectives of the learning teaching process;

[10] A **semantic cloud** (or *cloud of labels* or *words*, is a visual representation of labels (tags) or keywords used in a text. Semantic clouds are a new interface element that can allow a text analysis. The weight of the labels (or tags), which is rendered with characters of different sizes, is intended exclusively as frequency of use within the site. The larger the character, the greater the frequency of the keyword. The clouds of terms with the positioning of the terms also indicate their logical relationship, which in the text is expressed by the grammatical and logical forms used.

2. ***level of metabolization of the use of technologies***, of how technologies become transparent to students, to understand how technological "*competence*" becomes the ability to use one's own skills in a transversal way; the level of "metabolization" is evaluated during the observation phase through questionnaires and transforming the observations into a scale of values.

The intervention, which will be discussed below, provides that the teachers of the two areas concerned make a 20-hour speech (divided into 3/4 a week, for a period of 5/6 weeks).

This educational intervention includes a part of explanation in the classroom, of 4/6 hours and then laboratory work in which the students under the guidance of the teachers do exercises and use technologies to summarize what has been learned and prepare for:

- ***communication of the learned contents;***
- ***contents verification*** (classroom task).

The main content of the intervention from a content point of view focused on a scientific pH topic and a historical-scientific topic, the main socio-cultural-scientific events of the '900.

From a technological point of view, an electronic kit represents the content with acidity detection sensors and software that allow a semantically and logically defined structuring of the relationship between contents.

The research intervention program starts from the study and participation in experiences of teacher training and experimentation in educational robotics.

The experience of training teachers and future teachers has put me in contact not only with the need to teach the possible use of technologies in educational activities but also in front of requests for further information coming from the real school, from those who confronted each other day after day with guys.

The main stimuli came not so much from questions about how to use technologies but what skills they needed, what skills they changed and what skills they required.

Similarly, these questions were reflected on new demands and needs to train teacher professionalism.

The reflection and the preparation and delivery path of the training path for the students has led to hypothesize the need to imagine a path that does not chase the technological innovations but that would evolve the teachers' abilities to analyze and use the tools they become familiar for the students.

Reflecting on these stimuli, with the EURESIS Research Laboratory of the University of Ferrara, directed by Professor Gramigna, I thought that the starting point from which to derive research is the concept of cognitive style and how they are modified, in relation to the advent and spread of technologies.

This reflection gave rise to the setting up and administration, to a large sample of middle school teachers, of a questionnaire to understand if and how the influences of the use of technologies on cognitive styles and learning practices were perceived.

It was found that the same technologies could enhance those skills that seemed to have diminished.

In particular, the capacity for analysis and synthesis that seemed to be delegated to technology but that the same technology could increase if one thought of using technologies as a tool for understanding reality and communicating knowledge.

Starting from this survey and hypothesis, the intervention program in schools derived its intervention logic from educational robotics experiments that in Italy was and is developed by Robocup Jr Italia, a network of schools recognized by the Ministry of Education, of the 'University and Research (MIUR), founded in 2008 and involving over 200 schools of all levels.

The challenge of educational robotics is to develop, through technologies, effective cognitive styles that draw their strength from problem solving and learning methods by mistake.

We are seeing that robotics at school, together with coding, allows revolutionizing teaching and learning methods, making both more enjoyable for teachers, children and young people.

The research intervention aims precisely to see that in addition to the enhancement of learning skills, the interactions between students and between them and the teachers are also improved.

The research foresees a first questionnaire to find out what the teachers' perceptions about the influence of the use of technologies by young people are and how their skills are modified (see Annex A.1).

It was considered necessary to start the research a study on the repercussions of these changes and processes on training practices and their models, also considering the consequences, not always explicit, that both have with respect to behaviors and values.

We intend to do a first exploratory research; it is in the proposal of a school that aims at the enhancement of the talents of both teachers and students of secondary schools.

Yes, it is intended to do the survey of the thoughts of teachers, from their “feeling” of how the world of technologies and their pervasive use has influenced cognitive styles, and in any case on students, of secondary schools, skills and attitudes, regarding learning processes.

The research intends to proceed by using cognitive artifacts and educational robotics interventions in the context of learning scientific concepts and problem-solving skills, doing the same training without the use of “integrated” technologies.

The whole research intervention program intends to develop and verify how the use of technologies allows to improve on one hand the level of learning of the students but above all transforming the know-how into skills for a meta-cognition and a contextual use of acquired knowledge.

In particular, the research intervention wants to prove that the level of learning improves and, that technologies allow addressing topics with high semantic densities, providing analysis and comprehension skills of the cognitive network underlying each topic.

The intervention also aims at transforming the use of technologies into competences, i.e. the ability to understand the use of similar technologies and to associate technologies and their uses in a "transparent" way, at a level of cognitive unconscious.

The talk is based on a series of theoretical lessons on history and sciences in which the teachers dealt with three themes:

1. *the history of the '900, in terms of the main social and political events;*
2. *the main inventions of the '900;*
3. *the concept and measurement of pH.*

After these theoretical interventions, the experimental group had access to multimedia technologies to create documents and an online tool to assemble documents and produce a document describing the 20th century through political-social-scientific history and which could be presented both to comrades than lecturers.

As far as the concept of pH is concerned, the experimental group carried out a laboratory work with simple electronic elements, which allowed highlighting what implied from a practical point of view what were the simple notions acquired in theory.

This program of interventions aims to verify that this integrated methodology allows to improve the level of understanding and the level of learning in general as it develops a focus on the relationship between data to build knowledge.

Furthermore, the purposeful use of technologies produces the ability to metabolize the tools to make them into skills, but regarding their logic and purpose, not strictly linked to the only areas in which they were used.

The intervention program described so far, and rivals in the light of its correlation between the research questions and the hypotheses that gave birth to this work, had as its backbone the technologies, not as a specific tool but as a methodological approach.

The intervention program implements the use of technologies as integration in the learning-teaching processes, inserting into the path of school programs to improve the level of learning, developing analytical and synthesis skills, not modifying the educational objectives but evolving the educational tools.

This introduction of technologies is guided by a learning logic - teaching in a formal environment in which interactivity, accessibility and usability of technologies use to increase the level of learning.

A learning book measured not only in terms of results in the verification tests but also in terms of communication of the acquisition that highlights the degree of analysis and synthesis acquired.

Level of learning, analysis and synthesis induced and made to grow by technologies as an archetype of cognitive style that is developing in young people.

Starting from the hypothesis of the relationship between technologies and learning, which governed the planning of the fundamental intervention program, it was the decline of this main flow through the key words that controls an evaluation and enhancement of technologies regardless of construction logics and closely related to 'electronics.

Focusing attention on interactivity, accessibility and usability, and their regulation as independent variables means experiencing the effectiveness of:

- active student participation (*interactivity*);
- an inclusion and a path of "breaking down logical barriers" of educational tools (*accessibility*);
- an increase in endemic curiosity and perception of the learning path as a positive experience (*usability*).

The path of the research intervention can therefore be described as the development of a process inspired by what technology, understood as a relationship with data, information and knowledge, declined in a relationship of growth between the characteristics which makes the technology “reliable” and the development of skills that makes training “effective”.

Technology therefore supports learning processes - teaching is a support that not only increases the level of learning in the short term but increases learning skills through the features that identify from a logical point of view and of each technology.

CHAPTER VI.
Research's Finding

VI.1. Pre-experimental phase finding

The research started from the survey of teachers 'thoughts, from their "feeling" of how the world of technologies and their pervasive use influenced cognitive styles, and in any case on students of secondary school skills and attitudes, regarding learning processes.

It was decided to use a scale based on a Likert scale, in order to have a first response in relation to the focus of the research project by substantially placing some statements with respect to their evaluation of cognitive trends to the teachers' evaluation.

It was decided to use an "online" system for the administration of the questionnaires and specifically, through the school managers, the link to fill in the questionnaire was disseminated.

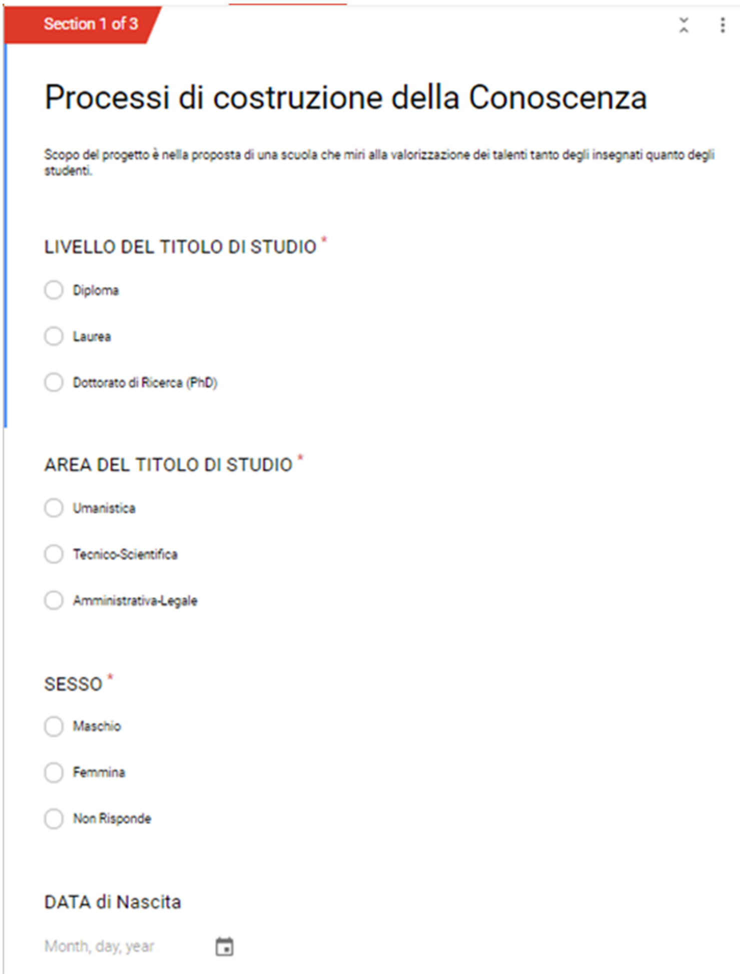
On the one hand, the choice was dictated by the need to have rapid feedback and on the other by the reflection that in order to refine a more in-depth questionnaire and the development of teaching strategies to experiment, it would be significant to gather opinions without posing a segmentation problem.

The focus was on secondary school teachers, even if vertical plexuses were also contacted, and questionnaires were obtained from teachers of primary and secondary level.

The questionnaire, which was accompanied by a letter of introduction, declared the purpose of the project, of which it was the

starting action, namely an analysis and a subsequent pedagogical proposal for a school that values the talents of all those who live there.

The questionnaire was divided into three sections and was intended for a brief but meaningful compilation.


Section 1 of 3

Processi di costruzione della Conoscenza

Scopo del progetto è nella proposta di una scuola che miri alla valorizzazione dei talenti tanto degli insegnati quanto degli studenti.

LIVELLO DEL TITOLO DI STUDIO *

- Diploma
- Laurea
- Dottorato di Ricerca (PhD)

AREA DEL TITOLO DI STUDIO *

- Umanistica
- Tecnico-Scientifica
- Amministrativa-Legale

SESSO *

- Maschio
- Femmina
- Non Risponde

DATA di Nascita

Month, day, year

Figure no. VI.1. *Section 1 of the questionnaire.*

The first section (see Figure no. VI.1.) was the compilation of data relating to the compiler in relation to the educational qualification, area of study, gender and age.

The second section 2 (see Figure no. VI.2.) collected data related to teaching and the order and grade of the school and the disciplinary area,

together with the survey of the length of service (how many years have you been teaching?).

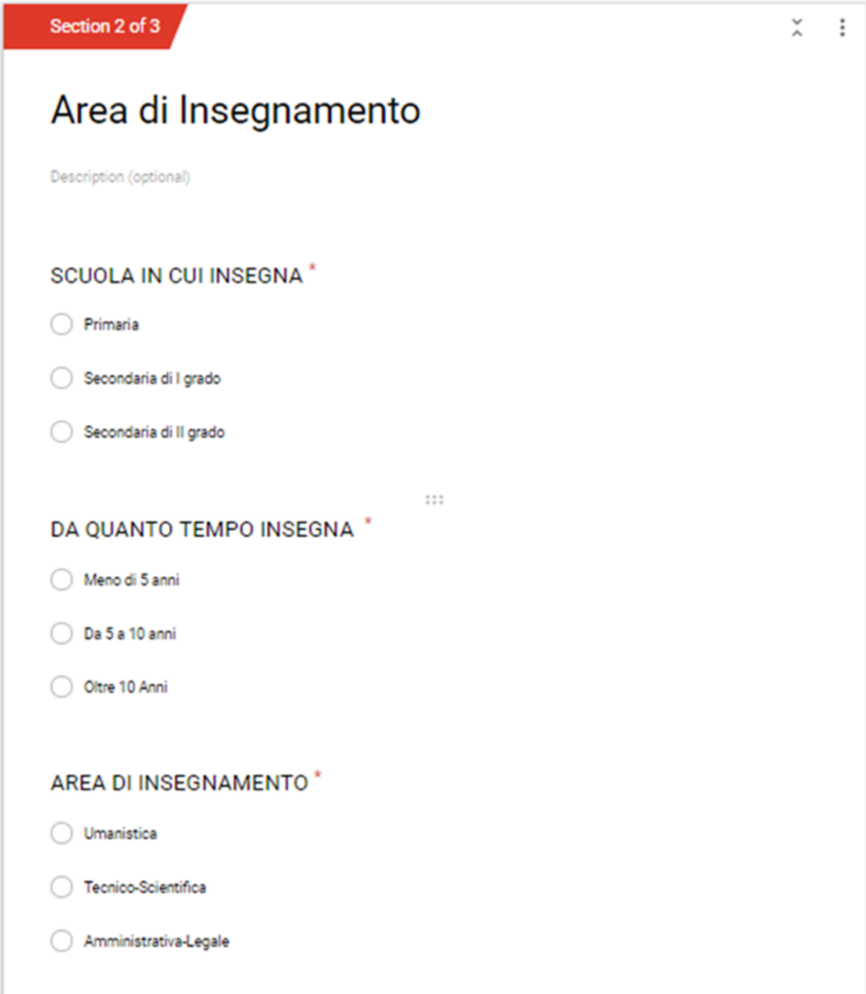
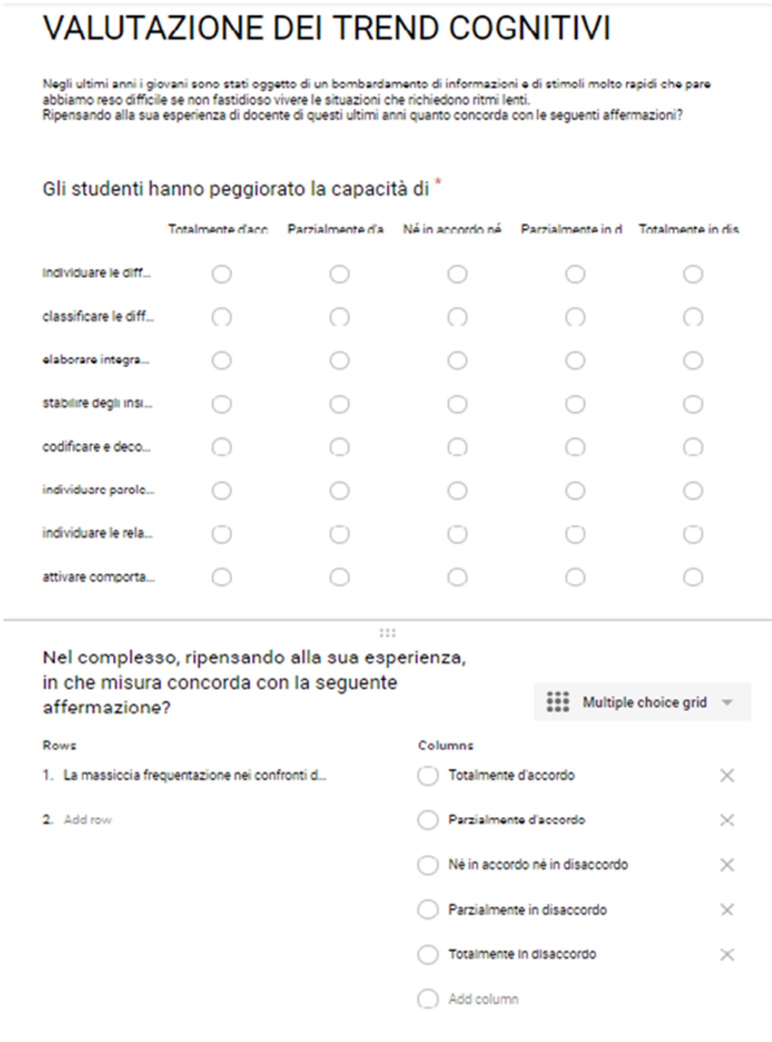


Figure no. VI.2. *Section 2 of the questionnaire.*

The last section is the fundamental one (see Figure no. VI.3.) "ASSESSMENT OF COGNITIVE TRENDS" for the detection of teachers' thinking and to be able to continue with the structuring of the project to define pedagogical models to detect and optimize cognitive processes.

This section consists of three questions, two closed and one open to collect suggestions and feelings from the teachers.

The first question is "In recent years, young people have been the subject of a bombing of information and very rapid stimuli, which seems to have made it difficult, if not annoying, to experience situations that require slow rhythms.



VALUTAZIONE DEI TREND COGNITIVI

Negli ultimi anni i giovani sono stati oggetto di un bombardamento di informazioni e di stimoli molto rapidi che pare abbiamo reso difficile se non fastidioso vivere le situazioni che richiedono ritmi lenti.
Ripensando alla sua esperienza di docente di questi ultimi anni quanto concorda con le seguenti affermazioni?

Gli studenti hanno peggiorato la capacità di *

	Totalmente d'acc	Parzialmente d'a	Né in accordo né	Parzialmente in d	Totalmente in dis
individuare le diff...	○	○	○	○	○
classificare le diff...	○	○	○	○	○
elaborare integra...	○	○	○	○	○
stabilire degli insi...	○	○	○	○	○
codificare e deco...	○	○	○	○	○
individuare parole...	○	○	○	○	○
individuare le rela...	○	○	○	○	○
attivare comporta...	○	○	○	○	○

Nel complesso, ripensando alla sua esperienza, in che misura concorda con la seguente affermazione?

Multiple choice grid

Rows
1. La massiccia frequentazione nei confronti d...
2. Add row

Columns
○ Totalmente d'accordo
○ Parzialmente d'accordo
○ Né in accordo né in disaccordo
○ Parzialmente in disaccordo
○ Totalmente in disaccordo
○ Add column

Figure no. VI.3. *Section 3 of the questionnaire.*

Thinking back to his experience as a teacher of the last few years, how much do you agree with the following statements? "; in relation to

this question possible answers are given that complete the statement *The students have worsened the capacity of* ..., and the statements are:

- or ... identify the differences (ANALYSIS);
- or ... classify the identified differences;
- or ... elaborate integrations between different elements (SUMMARY);
- or ... to establish sets of elements based on the principle of affinity or congruence;
- or ... encode and decode a message, a language, a code, an instruction, a program ...;
- or ... identify key words that connote an event or process;
- or ... to identify the relationships between the part and the whole of a context;
- or ... activate collaborative and supportive social behavior.

and for each statement you are asked to choose between the options of a Likert scale:

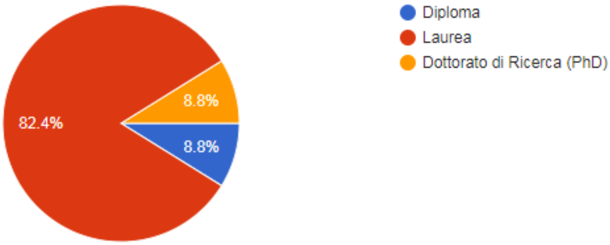
- ✓ Totally agree.
- ✓ Partially agree.
- ✓ Neither in agreement nor in disagreement.
- ✓ Partially disagree.
- ✓ Totally disagree.

Similarly, the next question, which contains a single statement; the question is Overall, considering his experience, to what extent do you agree with the following statement? and the statement to "evaluate with the same Likert scale seen above is: The massive attendance towards technological apparatuses by children and young people has played a main role in changing their approach to learning in the dimensions identified in the previous table of affirmations.

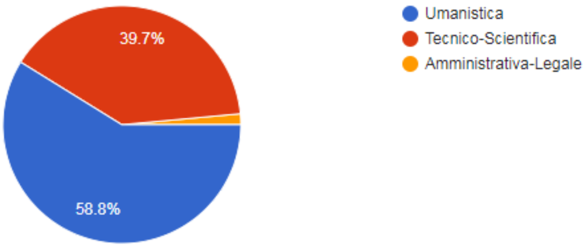
The collected questionnaires are 204 and, in the following tables, it is possible to see how the data are divided by section.

SECTION 1

Level Of Study Title	
High School	18
Graduation	168
PhD	18



Study Title Area	
Humanistic	120
Technical Scientific	81
Legal Administration	3



Level Of Education By Gender Divided	
Male	36
Female	165
Not responding	3

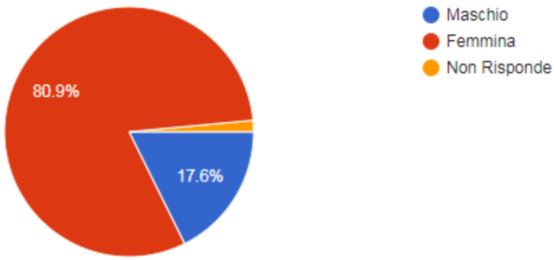


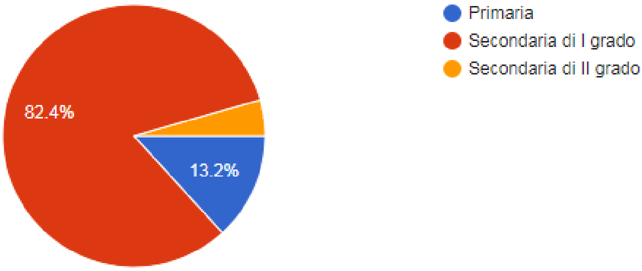
***Figure no. VI.4.** Data collected on the level and area of study of teachers divided by gender.*

As you can see even if the sample can be defined as random, the distribution reproduces a “realistic” situation; for example, to make a comparison with a certain figure in Italy, according to an OECD estimate, 83% of the teachers are women, which is comparable with 80.9% of the sample, as is the relationship between the different disciplinary areas.

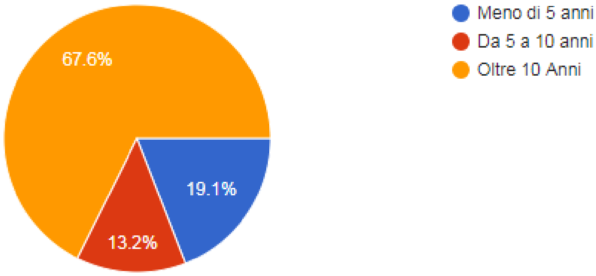
Continuing in the representation of the data collected, the data relating to schools and teaching areas will now be summarized where reasonable percentages are found which are compared with the national panorama.

SECTION 2

Level of school where teach	
Elementary	27
Secondary school	168
High school	9



How Long Teaches	
Less than 5 years	39
From 5 to 10 years	27
Over 10 years	138



Teaching Area	
Humanistic	126
Technical Scientific	78
Legal Administration	0

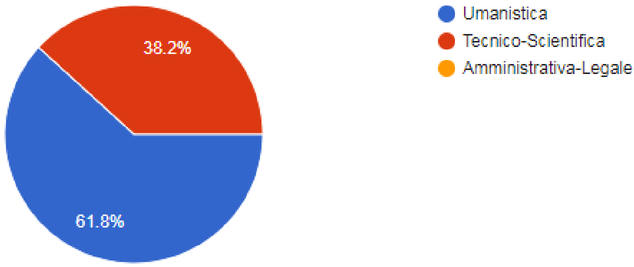


Figure no. VI.5. *Data collected on school level and teaching area.*

Analyzing, from a percentage point of view, the data once again the sample seems to be always satisfactory with a view to reliably analyzing the sensations with respect to the learning trends and being able to prepare design and analysis tools to continue the project.

The data relating to section three are the central ones that led to a first reflection and a first confirmation of the feeling that one had in the various contacts with the schools, that there is the actual need to question oneself and reflect on learning styles and rethink them in relation to technologies and the new way of communicating and taking information.

In summary, see Table no VI.1., the data collected in the third section with the reflections that they led.

SECTION 3

Table no. VI.1. *Data collected in the third section of questionnaire.*

STUDENTS HAVE DROPPED THE ABILITY OF ...	**Totally agree**	**Partially agree**	**Neither in agreement nor in disagreement**	**Partially disagree**	**Totally disagree**
... identify the differences (ANALYSIS)	**54**	**108**	**24**	**15**	**3**
... classify the identified differences	**69**	**102**	**21**	**9**	**3**
... elaborate integrations between different elements (SUMMARY)	**108**	**75**	**12**	**6**	**3**
... to establish sets of elements based on the principle of affinity or congruence	**66**	**87**	**33**	**12**	**6**
... codify and decode a message, a language, a code, an instruction, a program	**87**	**81**	**21**	**12**	**3**
... identify key words that connote an event or a process	**48**	**93**	**27**	**33**	**3**
... to identify the relationships between the part and the whole of a context	**78**	**81**	**30**	**12**	**3**
... activate collaborative and supportive social behavior	**48**	**78**	**36**	**27**	**15**

A first overall reading of this table shows the detection by teachers of a deterioration of certain skills; in fact, if we add the totally with the partially in agreement we can see that there is an evident detection of this deterioration.

There is an almost total concordance in detecting a diminished or worsened capacity for **synthesis** where there is an **89.7%** of interviewees completely or partially in agreement with the statement.

Similarly, there appears to be evidence of progressive deficiencies in the ability to classify differences (**83.8%** Totally + Partially in agreement).

Of interest is to note that a very high percentage **82.1%** (Totally + Partially agree) shows a diminished ability to *encode and decode a message, a language, a code, an instruction, a program*, where undoubtedly today the relationship with technologies is privileged and the technologies themselves are pervasive.

This is certainly a first indicator of where to continue an investigation, because this result highlights how technologies become memory substitutes and information cataloging, also explaining the need for schools to push for coding, for the development of computational intelligence.

The aspect of coding and the development of computational thinking, as well as emerging need in the school explains why, in the analyzed questionnaires there is a strong correlation between those who disagree, partial or total, with the statements and their membership by training or teaching area for the technological areas.

Similarly, there is a direct correlation between the neutral elements and the relative brief experience, on average 90% of the answers neither in agreement nor in disagreement is related to teachers with less than 5 years of teaching who for this reason are not able to perceive variations to cognitive styles.

Probably in this case it is evident that technology and technology are too often confused and that the ability to use tools is "confused" with new learning styles, which in some way displace the previous ones.

A separate discussion and of interest also for the relational area are the "reactions" to the affirmation the *students have worsened the ability to activate collaborative and supportive social behaviors* where **61.5%** agree

completely or partially but disagree total or partial there is a **20.6%** and a percentage of neutrals of **17%**.

This is interesting because it reveals what is the influence of social networks that are judged on the one hand a source of isolation, and even more serious problems such as cyber-bullying and on the other hand to increase socialization and all those collaborative stimuli useful not only in new social processes but also in learning processes.

On the other hand, there is a clear indication from the analysis of the reactions from the last statement.

The massive attendance towards technological apparatuses by children and young people has played a main role in changing their approach to learning in the dimensions identified in the previous table of affirmations, relating to the question *Overall, when thinking about your experience, to what extent do you agree with the following statement?*

The percentage of totally and partially agreed is 88%, with absolute values that are shown in the Table no VI.2.

Table no. VI.2. *Data collected in the third section of questionnaire bis*

Totally agree	Partially agree	Neither in agreement nor in disagreement	Partially disagree	Totally disagree
102	78	15	6	3

This result, even in all the facets seen in the individual reactions to the other statements, confirms that the pervasiveness of "intelligent" technologies and tools is felt as a "cause" not only of social and relational changes but also in the way in which individuals they relate to the construction of knowledge and the same cognitive styles.

The project therefore encouraged by the observation that what were "sensations" are strong evolutionary impulses even within the school and that these thrusts sometimes generate problems that must be tackled in a structural manner.

Among the few additional comments that teachers have placed in the questionnaires, one seems relevant to me: "The massive attendance of

the technological apparatuses, in my opinion did not affect much the learning abilities, but rather the poor management of the contents. Many children delegate essential knowledge to the memory of their phone, not knowing how to retrieve them to activate the abilities contained in the table."

This means that the next step in the research, comforted by the detection of these needs, is that of detecting cognitive styles, because if the abilities have not changed, perhaps the way of using them or perceiving them as a capacity has changed.

The results of this first survey will therefore be to set up tools to detect cognitive styles on the one hand and "educational" styles on the other, in the perspective of an increasingly technological society permeated with information and data.

This will therefore be the springboard for defining virtuous processes that allow the integration of cognitive styles, technological evolution and people's relational capacity.

We work and study to be able to say with the philosopher William James "The greatest discovery of my generation is that human beings can change their lives by changing their mental habits".

The pre-experimental phase, as the data revealed, shows how technology has changed the cognitive styles of children and analysis and synthesis, as hypothesized.

If one imagines defining some risks of technologies, on the one hand it is certainly the delegation that they are made to "analyze" what we see and on the other hand the synthesis is delegated, for example to search engines or to all those tools capable of do semantic content analysis.

As also hypothesized, teachers are interested and willing to work to make operational capabilities reconvert into technological abilities that re-evaluate all cognitive potential.

The reading of the results of the survey with the professors finds me in agreement on the detection of the decrease in synthesis and analysis capacity due to a non-guided use of technologies.

For the reason one of the focus of the research is, starting from this evidence, to verify the potential of the technologies that can allow developing new competences aimed at an analytical and synthetic approach to knowledge.

Using the Google Forms, some general information was collected to define student profiles in relation to general data (gender, maximum level of schooling in the household) and data on their level of familiarity and use of technologies and which technologies were available and the use made of them outside the context of formal learning.

Table no VI.3. *Data collected in first part of the questionnaire (Gender of students)*

GENDER OF STUDENTS OF SECONDARY SCHOOLS DIVIDED BY CLASS			TOTAL STUDENTS OF SECONDARY SCHOOLS
Class	M	F	
I	22	39	61
II	24	41	65
III	25	31	56
Total	***71***	***111***	***182***

Table no. VI.4. *Data collected in first part of the questionnaire (Family study degree)*

MAXIMUM DEGREE OF STUDY IN THE FAMILY CORE	
No Title	2
Elementary	3
Secondary school	6
High school	53
Degree	109
PhD	9
Total	***182***

The submitted questionnaire had a part of collection of "objective" data and a series of scales of values relating to "cognitive" and "use" data

The first survey was on the gender, class attended, and the highest degree of parental education and the following table summarizes the results of this first part of the questionnaire (see Table no VI.3. and Table no VI.4.).

It seemed appropriate in this first phase of survey, to have data also on the technological tools that the kids use, or that they have available, to assess how much their knowledge in terms of BYOD and BYOB is influential from a process point of view cognitive.

These questionnaires were also filled in to the control group, and the tables of the obtained data will be reported later.

Returning now to the questionnaires to administer to the students of secondary schools during the research a second questionnaire concerned the technological tools that the boys had at their disposal, personal and in the family and what their familiarity was with the use of technologies and tools for the creation of Multimedia and interactive "objects" such as video, sound or editing and editing of images and videos.

In relation to this questionnaire, the results obtained are shown in the Table no VI.5.

Table no. VI.5. *Data collected related to devices owned or available*

TECHNOLOGICAL TOOLS AVAILABLE		
Device	*Personal*	*Available in the family*
PC	7	163
Laptop	103	143
Tablet	134	42
Smartphone	182	146
Book Reader	2	3
	Total	***182***

This explains the fact that technologies are part of the experience of children by attenuating the effects of fear or "*mythicization*".

In parallel, both the experimental group and the control group were asked to say for what reasons they use the technologies, thus also detecting the elimination of a gap between the possible capabilities and the functions that are "delegated" to the technology.

All these data (see Table no. VI.6.) were also collected using Google Forms filled directly on the computers of the computer labs.

Table no. VI.6. *Data collected related to type of use of devices owned or available.*

USE OF DEVICES					
Device	*Game*	*View multimedia content (movies, videos ...)*	*Social Network*	*Learning*	*Content production (video, photo, writing)*
PC	25	2	5	63	120
Laptop	12	21	6	71	90
Tablet	40	25	12	3	6
Smartphone	50	40	160	18	140
Book Reader		1		4	

The data collected among the students in this pre-experimental phase were functional to understand whether the students' skills and familiarity and the family environment were.

In the case of discontinuous results in the experimental phase or important difficulties regarding technology, it was possible to investigate whether they were prerequisites for integrating technologies in teaching processes.

Important are the percentages of use of the technologies (see Figure no. IV.6.) by the boys, in their free time as well as in informal and non-formal training environments.

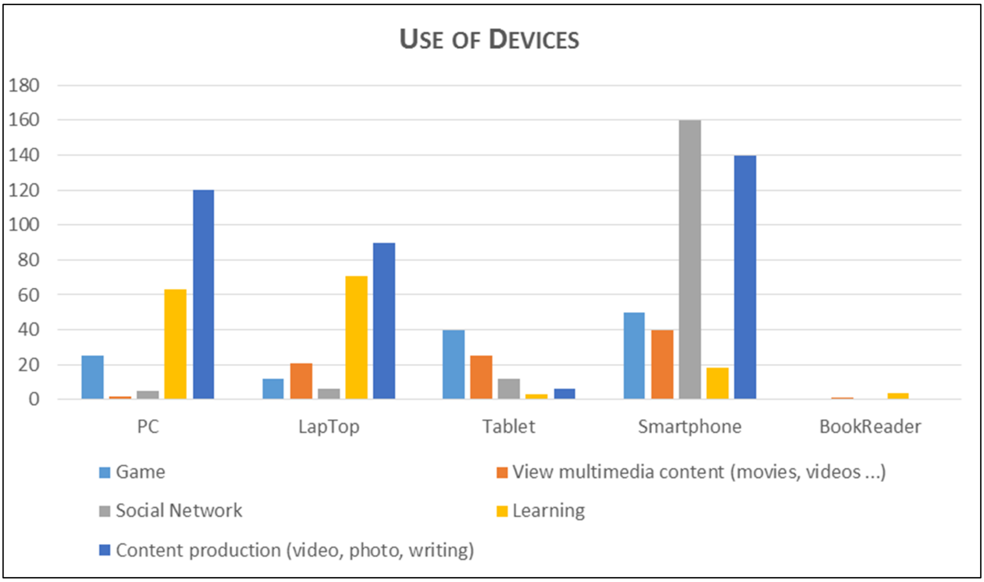


Figure no. VI.6. *Use of technologies by student*

The competences were therefore generalized and, even the control group continued to use the technologies as it did previously.

The skills are all functional, not interested in knowing the computer skills but the familiarity with digital systems.

VI.2. Post-experimental phase finding

The dependent variables that have been taken into consideration are (see Table No. V.2):

- *Interactivity of technology*
- *Accessibility of technology*
- *Usability of technology.*

In the light of the data collected by the experimental group, the tools and technologies used in the intervention program should be considered characteristic.

As far as interactivity is concerned, bearing in mind the number of functions that the boys have used and the high personalization that has been made of them, the frequency to induce an aware and meaningful use is fundamental.

Similarly, given the diversity of functions used and the management of communicative graphic information, it is important to measure the range of variability that helps to develop the ability to relate the instrument and purpose of use.

In relation to problem solving techniques (such as the use of sensors to detect pH) the Relief is an indication of the effectiveness of the technologies.

Which highlights the relationship between technological and instrumental choices with the solution of problems.

After this first part of the collection, the research intervention took place, in a first phase with a series of works following the explanation by the teachers of a series of historical social and scientific events of the '900.

In particular, a journey has been made according to the **AUM** (**A**pproach, **U**se and **M**etabolization) approaching and using an online, standard and free tool, the H5P environment an open source plug-in that allows the creation, sharing and content reuse (See Figure no. VI.7.) multimedia and interactive, such as presentations, games, tests, interactive videos and multimedia and interactive time-lines.

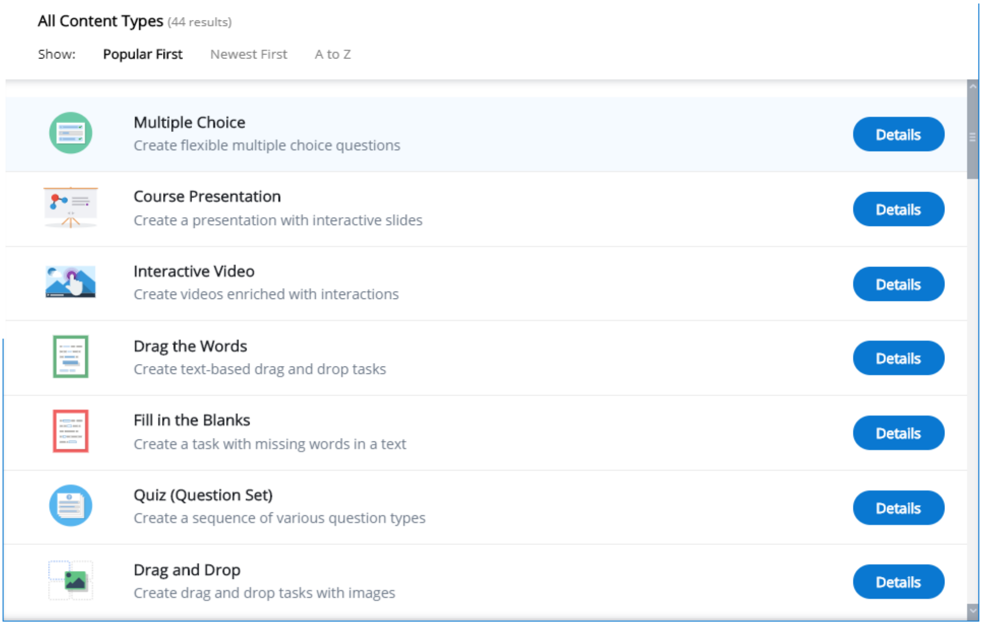


Figure no. VI.7. *Selection window for creating content that can be created in H5P.*

H5P has the advantage of allowing the use of the resources available on the web that can be used as teaching and learning materials, making them interactive and creating objects that can be integrated into the teaching platforms, LCMS (Learning Content Management System), such as Moodle and CMS (Content Management System)) like Drupal or Wordpress.

Furthermore, a tool that contains interactions and standard and prototype tools allows us to evaluate whether the technologies integrated in a didactic path to put the development of skills related to knowledge but also relational and linked to cooperative and collaborative learning.

The approach phase carried out in the first 2-hour meeting allowed the students of secondary schools after a brief explanation to become familiar with some of the types of creatable objects, but also with the creation interface as well as a familiarization of terms, the interface is in English, but the habit of online games and the language of social networks did not appear, from the data, to be a high difficulty or not overcome.

The difficulties and the evaluation of the instrument and the ways of overcoming the difficulties were detected through a questionnaire administered, again with the Google Form, compiled by the computers in the computer rooms using a link that clearly showed the anonymity of the questionnaires.

In the submitted questionnaires, the division by classes no longer appears because the age difference, 11-14, is such that the data is not relevant.

A class-related and integrated judgment in the research is a qualitative assessment given by the teachers who have observed the working methods of their students of secondary schools.

Table no. VI.7. *Difficulties encountered by students in using H5P environment.*

H5P ENVIRONMENT (POSSIBLE MORE CHOICES)	
Difficulties detected	***Students of secondary schools***
No difficulty	143
Interface too complex	35
Problems with the language (English)	53
Unintelligible commands	25
Difficulties in content management (allowed formats, file sizes ...)	20

Since it is evident (see Table no VI.7.) that those who have encountered one or more difficulties are 39 pupils (182-143) about 20.4%, 1/5 had one or more difficulties and they also filled in the part of the form that asked them to specify how and if they have overcome the difficulties, which was the main route, highlighting a strong component of trust in

the companions, highlighting the implementation of an important collaborative mentality in a climate of inclusion (see Table no VI.8.).

Table no. VI.8. *Help for difficulties encountered by students in using H5P environment.*

H5P ENVIRONMENT DIFFICULTIES	
Solution / Help	***Students of secondary schools***
I did not overcome the difficulties	1
I tried it alone	1
I asked the teacher	2
Asked the comrades for help	35
Total	***39***

After this first phase of "familiarization" with the instrument, the children were given the task of choosing one of the multimedia contents present to make a brief presentation of a favorite comic, a game or the last film seen to finalize the use of one contained in a communication and a summary of known contents.

In these phases, the boys were formed in groups of 3 or 4 people and worked on shared computers and the choice of tools offered by H5P.

Noting the choices of the boys, of the xx groups that had formed, we saw that although different classes and at different times the attention was focused on 3 types of instrument, as shown in the Table no VI.9., to suggest that they represented prevailing cognitive models.

Table no. VI.9. *Tools used in H5p*

TOOLS USED IN H5P	
Tool	***Group (students of secondary schools)***
Interactive Video	18 (56)
Time Line	27 (86)
Virtual Tour 360°	8 (27)
Interactive Book	2 (6)
Memory Game	2 (7)
Total	***57 (182)***

It can be noted that the tools chosen to represent a modality of relational approach to knowledge.

That is an explanation through technological tools of the necessity and the propensity to communicate the very many information that are correlated between them, as if to make explicit connections necessary to "orientate" in society of the information in which the school is immersed people are completely immersed.

This second phase has occupied 2 meetings for a total of 4 hours and is placed in a phase of use of the instrument.

The last phase of metabolizing the 6-hour instrument was to give the children the task of using the Time Line tool to synthesize and communicate what had been learned during the teachers' explanation of a series of historical social and scientific events from the 1900s.

This last phase saw the different groups then use the tool created by another group, evaluating it with a simple numerical scale with respect to 5 parameters from 0, not at all to 4 totally; the evaluation was given individually by each individual boy, after he had been given an hour for viewing and browsing the contents.

Using Steve Krug's theories, for an empirical assessment each group was given a random product, created by another group to be evaluated.

It is interesting to understand the design and communication skills that students of secondary schools have implemented, and the following table summarizes the number of products that have achieved a value in a characteristic.

The Table no. VI.10. shows that there is a considerable degree of communication in the products produced; it should also be noted that in the evaluation there was certainly a component of "competitiveness".

The last phase of this part of the research was a task in the classroom, in the form of a theme that called for "*Telling and detecting the salient facts of the '900 and their relationships*" administered to both the research group and the control group.

The results obtained, the boys were aware that the evaluation was effective, they were compared with the average marks of the individual students of secondary schools on their previous journey and the results are summarized in the Table no. VI.11.

Table no. VI.10. *Considerable degree of communication in the products produced*

EVALUATION OF PRODUCT FEATURES					
Feature	***0***	***1***	***2***	***3***	***4***
Level of interactivity	2	3	11	33	8
Different types of Media	1	3	22	22	9
Easily readable content	0	6	12	31	8
Understanding the contents	0	0	15	27	15
Understanding the structure of the contents	1	0	21	25	10

Table no. VI.11. *Average marks of the individual students of secondary schools in experimental group.*

EXPERIMENTAL GROUP TEST ASSESSMENT (182 STUDENTS OF SECONDARY SCHOOLS)		
Variation of the average	***%***	***Students of secondary schools***
<= -2	1,1	2
Between -2 e -1	2,7	5
Between -1 e 0	3,2	6
Between 0 e 1	30,9	56
Between 1 e 2	59,4	108
>=2	2,7	5

Table no. VI.12. *Average marks of the individual students of secondary schools in control group*

EXPERIMENTAL CONTROLL GROUP ASSESSMENT (54 STUDENTS OF SECONDARY SCHOOLS)		
Variation of the average	***%***	***Students of secondary schools***
<= -2	0	0
Between -2 e -1	3,7	2
Between -1 e 0	40,7	22
Between 0 e 1	50	27
Between 1 e 2	5,6	3
>=2	0	0

The same test and the same comparison was done with the control group obtaining the results shown in the Table no. VI.12.

At the end of this experience, a focus group was then held with the teachers who had participated to evaluate the overall attitude and the results obtained by the students of secondary schools of secondary schools together with the evaluation of their attitude.

The teachers agreed to positively evaluate the impact of the technologies on the integration of the didactic path, the terms of increasing the relational skills and the inclusion of the students of secondary schools.

Secondly, both data and observation have given positive signals with respect not only to the acquisition of technological skills but also to an understanding of technological processes known to students of secondary schools but not understood in their actual potential

The results obtained and the evaluations of the lecturers have meant that, although further experiments are needed in this regard, that the technologies so used and tested in this work, help to improve the capacity of SYNTHESIS ... *elaborate integrations between different elements* (SYNTHESIS) that had been identified, from the initial research among teachers, as a lack that a pervasive use of technologies had generated.

It can be said that the use of interactive technologies and content creation processes in formal learning processes increases the ability to synthesize and metabolize knowledge together with the facilitation of inclusion processes, which include the development of work skills collaborative and cooperative.

Dynamics that were not detected in the control group where, in addition to the normal transmission teaching, the IWB is used, as in many schools, but the interactive and participatory processes are not seemed to influence or to mature integration processes or collaborative or cooperative work skills.

We then moved to the experimental phase in a more concrete and technological area, closer to educational robotics and to the concepts of coding.

This second phase of the research starts from the fact that it was also reflected that the use of technologies in formal learning processes is that these allow us to consider as data source what had never been given an information capacity.

So, it becomes important to understand and make understand, with technologies how to correlate data to information and to know.

Analyzing processes and relationships, understanding them implies knowing and being able to communicate them.

The positive assessment that this experience of the use of electronics and educational robotics was the result of the teachers' evaluation of the realization and presentation of infographics (the most significant ones attached in the appendix) by the work groups to explain the concept of acid and basic.

The Table no. VI.13. on a scale from 0 to 4 given to the teachers, assesses the level of understanding of the concept of acid and basic as a function of how it was exposed, with the help of the infographics presented.

Table no. VI.13. *Assesses the level of understanding of the concept of acid and basic (experimental group).*

UNDERSTANDING LEVEL OF PH	
Scale	***Students of secondary schools***
0 Not understood	1
1 Only the general structure happens	5
2 The structure and the relationship between acid and basic are understood	30
3 Understand in its theoretical aspects but not completely the practical consequences	75
4 Understood in its theoretical and practical aspects	71
Total	**182**

With the classic explanation, in the classroom with the help of LIM and descriptive examples, by producing infographics the teachers evaluated the control group students of secondary schools thus highlighting the lack of structural understanding of phenomena (see Table no. VI. 14.).

Table no. VI.14. *Assesses the level of understanding of the concept of acid and basic (control group).*

UNDERSTANDING LEVEL OF PH (CONTROL GROUP)	
Scale	*Students of secondary schools*
0 Not understood	2
1 Only the general structure happens	7
2 The structure and the relationship between acid and basic are understood	9
3 Understand in its theoretical aspects but not completely the practical consequences	31
4 Understood in its theoretical and practical aspects	5
Total	**54**

The experience on the acquisition by the boys of a heuristic method that the technologies facilitate is also based; a method that represents an aspect of the scientific method that includes a set of "creative" strategies, techniques and procedures to search in a field of interest for a topic, a concept or a theory suitable to solve a given problem.

In this experience, ARDUINO was used as electronics because "it is an open-source electronics platform based on easy-to-use hardware and software" and was born in 2005 at the Interaction Design Institute of Ivrea (Italy) in order to overcome the lack of an economic platform, for the implementation of physical computing projects and which has 16 versions.

The version used in the search is Arduino Uno with the features:

- Atmel Atmega328 micro-controller with a speed of 16 Mhz;
- 6 inputs to acquire and process analogue signals;
- 14 digital pins programmable as inputs or outputs;
- power supply either through the specific connector or via USB

Also, in this phase of the research, a meeting was dedicated to the explanation of the use of the instrument and with the survey questionnaires.

This questionnaire is comparable data with the survey in the case of H5P occurred, highlighting how mental models and the cognitive style linked to pervasive technologies is not linked to a specific tool or

application, as well as the level of cooperation and collaboration, as well as inclusion is developed with these methodologies.

Table no. VI.15. *Difficulties encountered by students, in use of Arduino.*

ARDUINO DIFFICULTY DETECTED (POSSIBLE MULTIPLE ANSWERS)	
Difficulties detected Students of secondary schools	***Students of secondary schools***
No difficulty	130
Interface too complex	30
Hardware assembly problems	48
Problems of understanding the programming	32
Difficulty in managing the sensors	25

Since those who have encountered one or more difficulties (see Table no. VI.15.) are 52 students of secondary schools (182-130) about 28.5%, a little more than 1/4 had one or more difficulties and they have also completed the part of the form that asked for specify how and if they have overcome the difficulties.

Which was the main route, highlighting a strong component of trust in the companions, highlighting the implementation of an important collaborative mentality in a climate of inclusion (see Table no IV.16.).

Table no. VI. 16. *The strategy of solving problems encountered by students, in the use of Arduino.*

ARDUINO	
Solution / Help	***Students of secondary schools***
I did not overcome the difficulties	2
I tried it alone	6
I asked the teacher	5
Asked the comrades for help	39
Total	**52**

In the opening phase of this second phase of the research it was good to have a common base of knowledge that could not have been acquired.

So, in the first meetings, in addition to the introduction of the tools, some basic concepts were introduced such as the concept of atom

and molecule and subsequently of the molecule of the water schematized with its two elements:

- *hydrogen* **H** (to which the color red);
- *oxygen* **O** (which has been given the blue color).

in addition, how, by schematizing each atom as a ball, the fact that these balls are in equal numbers makes water a neutral substance: colorless, odorless and tasteless.

This was followed by the schematization of the HP grades to define acids and basics, after which each group, formed with the same rules of the previous research phase, was given the circuit diagram.

The operation of the circuit was understood by about 97% of the students of secondary schools, only 6 declared perplexity or not to understand the functioning, but by virtue of the cooperation, the assembly of the circuits was easily completed, understanding also the interconnection to the sensors data that they detect.

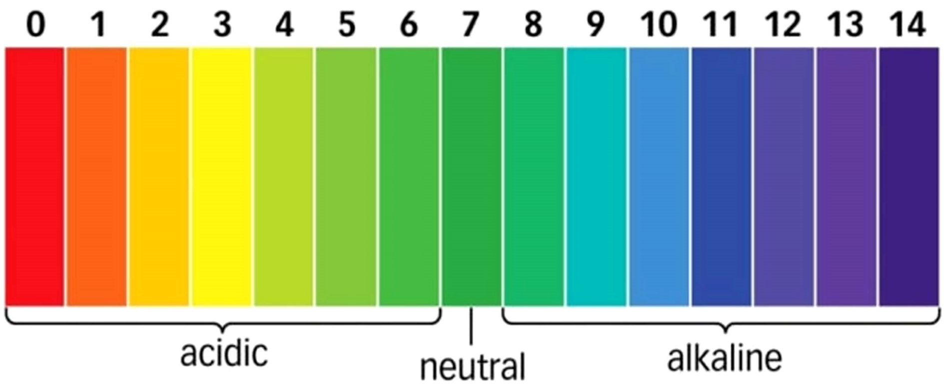


Figure no. VI.8. *Colored scale of pH levels.*

From a practical point of view the process was:

- delivery to each group of a jar containing the acid solution (vinegar, lemon juice and pear juice) of which to measure and record the pH;

- pouring of red cabbage juice into the jar containing the solution to check that the resulting color, associated with the previously measured numerical value, is easily matched on the pH scale (see Figure no. VI.6.) and this makes the meaning immediately understandable;
- procedure repeated with basic solutions (toothpaste, detergent and soap).

For a final test, Coca-Cola was chosen as a well-known beverage and each group is given a jar containing Coca-Cola, asking in advance to define the pH value; to this question, no one gave the correct answer and then the measurement was performed with the sensors.

Arduino was chosen by virtue of its ease of use, and therefore of management by teachers without strictly technical skills, which allowed each group to be an active part in an experience that is part of "learning by doing".

Even more evident in this experience is the "cooperative learning" method which produces and triggers the development of relational skills aimed at achieving a common goal and problem solving.

You become able to ask questions and not just give answers by applying formulas.

With this experimental part too, it can be stated that the use of technologies integrated in the teaching-learning processes in formal contexts has been tested and verified, with the use of Learning Objects and cognitive artifacts develops cultural, learning and relational, especially developing important problem-solving tools.

In relation to the **nomothetic objective**, it is possible to point out that from the point of view of the evaluation parameters of Learning Objects and methods of educational robotics, as could be expected only the level of interactivity and collaborative tools makes a technology assessable as more or less effective in a teaching-learning process.

Simplicity of use, level of interactivity, accessibility and usability, measurable with inspection or empirical tests, such as those cataloged by Cantoni, or heuristic laws such as those of Nielsen or the WCAG directives (of W3C9 seem to be the indicators to date) allow us to say that a tool is "transparent" to the user so it can be used as a cognitive tool in formal integrated learning processes and supported by technologies.

The results obtained both from surveys of questionnaires, tests and focus groups can be said that we can talk about ***internal validity*** and ***construct validity***.

The ecological validity, although having acted on real contexts, can be reasonably hypothesized but it needs further experiments in the field as well as the statistical validity that even if hypothesized, requires a greater number of data, given a remarkable variety of school situations on the national territory, employees from social and cultural contexts strongly differentiated in the Italian and ecological system.

The ***external validity*** is certainly verified even if limited to the social and cultural environments that can be referred to the situation of northern Italy, based also on a "*homogeneity*" of the survey of the teachers' feelings in this geographical area, also cultural, social and economic.

The experimental phase has shown that the hypotheses have been verified. In fact, the numbers presented both for the use of "IT" technologies, to produce time-lines, and for the pH measurement electronics have meant that for the elements of the experimental group:

• the level of learning has improved

• a strong sense of learning community has developed

• the technology becomes the competence to relate available environment-tools and operational possibilities.

As regards the level of learning, the results of the control group, substantially in line with the previous one, and this was predictable, but

this reinforces the conviction that the starting hypotheses have found confirmation and must be reiterated these processes and defined the design methodologies enriching them with those aspects not touched by this research, such as cognitive difficulties.

At this point we believe it is necessary to summarize and recall the principles, processes and results obtained in the experimentation intervention.

It may be recalled here that the work developed on a track of analysis of technology and its use in learning teaching processes.

Analysis and experimentation have tried to highlight the cognitive and learning logic that technologies have highlighted.

Evaluating and reassessing the potentialities of using information, multimedia and network technologies is the aim of the research, not forgetting the critical points that the technologies themselves have introduced.

Critical issues that we are interested in as they sometimes seem to conflict with the potential of the tools themselves, but which once again highlight the need to train a professional teacher who deals with technology from a methodological point of view, understanding its logical-connective structure that underlies it.

The research focused the focus on the learning outcomes of middle school students in whose program topics related to their study path were included.

Their subjects of humanistic and scientific area have been explained; for the humanistic area the main social, economic and scientific facts of the '900 and for the scientific area the understanding and the meaning of pH (a scale of measurement of the acidity or basicity of an aqueous solution).

For this reason, both the experimental group and the control group underwent learning-teaching processes.

The experimental group was provided with study and teaching tools that used software technologies for the humanities and hardware for the scientific area.

At the end of these processes, tests were conducted to verify the learning of the contents and to communicate the contents themselves.

Among the skills that the middle school aims to develop in students is communication and communicating content is an indicator of their understanding; one often cites an aphorism that is attributed to Einstein: *"I will know to know something when I know how to explain it to my grandmother"*.

We measured in terms of average increase of the evaluation both experimental group and of the research group, for the humanistic area (see Figure no. VI.10.) and measured the level of understanding of the concept of pH (see Figure no. VI.11.)

The hypothesis of the positive influence of technologies in the learning process is verified by the analysis of the percentage increase of the averages in the assessments and by the percentage of students who have understood the concept of pH and its implications.

The **Figure no. VI.10.** shows the graph with the percentages of increase of the evaluation and the level of understanding in the experimental group and the **Figure no. VI.11.** for the control group; 90.3% of the experimental group increased its performance against 55.6% of the control group.

Similarly, for the concept of pH 171 students 182 (see Figure no. IV.10.) have understood the practical and theoretical aspects of the pH against 5 out of 54 of the control group (see Figure no. VI.9.).

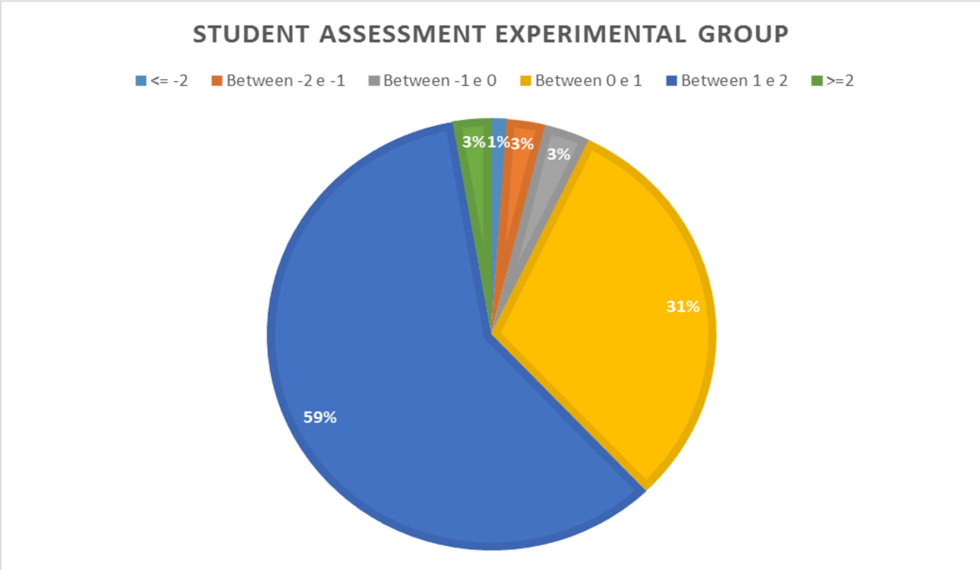


Figure no. VI.9. *Evaluation both experimental groups.*

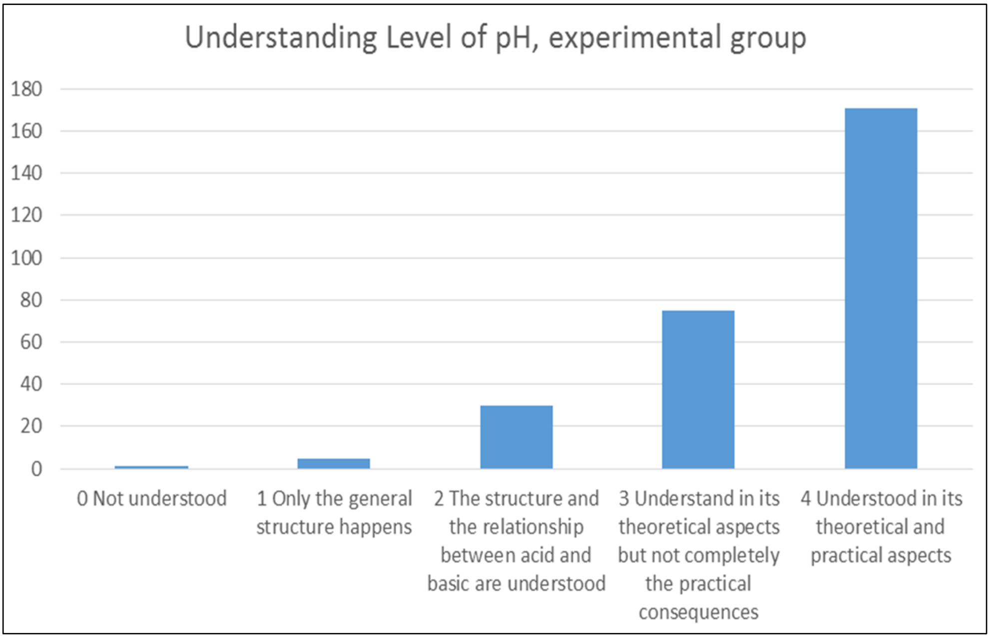


Figure no. VI.10. *Evaluation both experimental groups.*

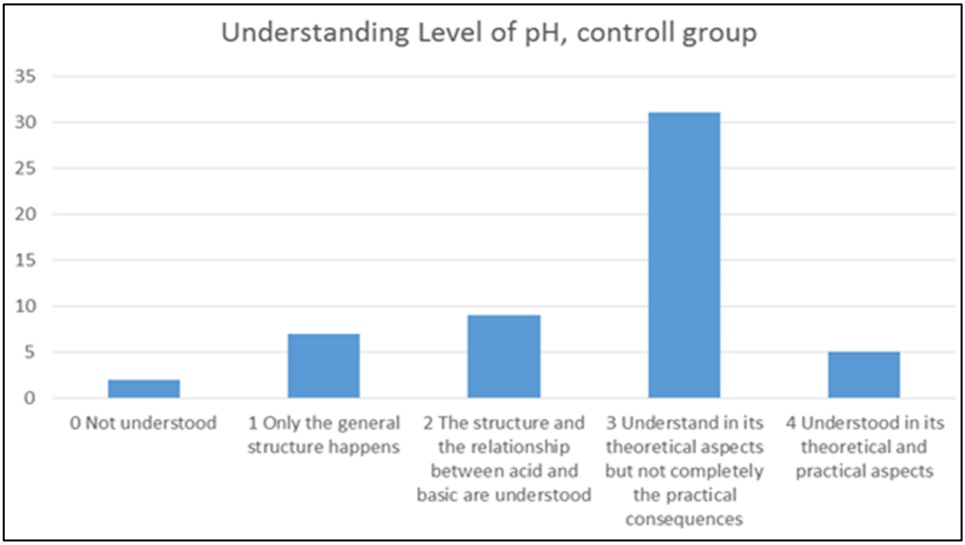


Figure no. VI.11. *Measured the level of understanding of the concept of pH*

The graphs allow highlighting the decisive relationship between learning connection logics and the possibility of being able to implement them through technologies; an implementation that needs and stimulates a knowledge determined by the connection between data that generates information.

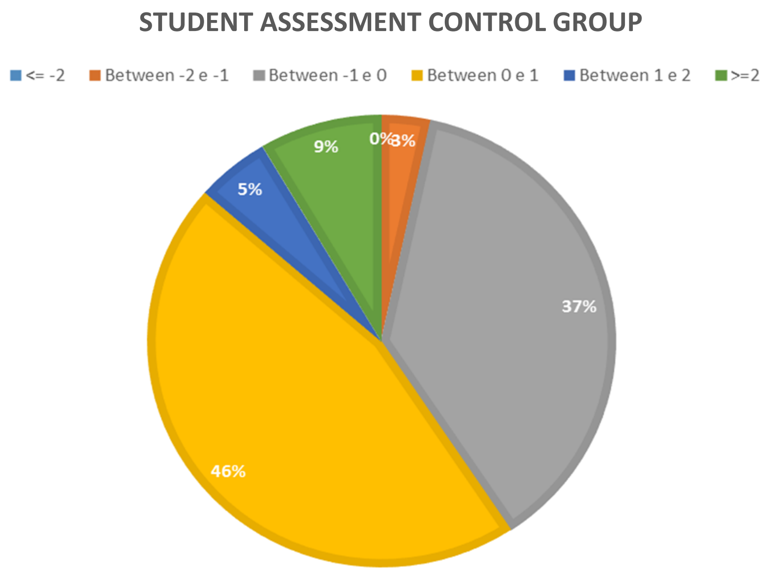


Figure no. VI.12. *Evaluation both control group.*

This surely determines an extremely positive reading and a positive impact of the technologies in the learning processes.

The data determine that the hypotheses of the use of technologies produces a more effective knowledge.

Effectiveness is the result of logical reconstruction and a correlation between the notions, data and findings that are obtained from reality, from literature and from teachers.

To measure the reliability of the data the **Cronbach Alpha** was calculated in consideration of the fact that it is a statistical indicator used to measure its reliability in psychometric tests.

Cronbach Alpha is to verify the reproducibility over time, on equal terms, of the results from they provided and was designed by the American educator Lee Cronbach in 1951.

The formula is expressed as:

$$\alpha = \frac{k}{k-1}\left(1 - \frac{\sum_i^k \sigma_{Y_i}^2}{\sigma_x^2}\right)$$

where k is the item number, σ_x^2 is the variance of the total score, and $\sigma_{Y_i}^2$ the variance of the item **i** for the sample of individuals under examination.

For the evaluation an EXCEL spreadsheet was used and by inserting the 6 items of the 182 students of the experimental group Cronbach's Alpha = 0.83 (see Annex A.7) was obtained, an excellent result considering that high reliability values are to be considered those ranging from 0.70 to on.

Cronbach's Alpha = 0.59 obtained from (see Annex A.8) the control group shows the greater "randomness" of the results and consequently a low correlation between the teaching method and the learning, more closely linked to factors due to the student.

The empirical research as it is configured and the results that it has proposed even in the limit of the sample and of a well-defined reality in

which it took place, presents an interesting relationship to the use of technologies and the effectiveness of teaching-learning processes.

Empirical research must certainly be extended so that technology, with its epistemological, cognitive and relational implications, can become one of the cornerstones on which to develop formal training environments.

Surely, the research has also brought out the feeling of a strong inclusive factor that technologies can bring.

We could say with a phrase attributed to the physicist Edward Teller during a conference that today's science is the technology of tomorrow, so we should again have the knowledge of science of the past to allow children to build an effective technology for the future.

A last reflection on the collected data leads to report such data with the hypotheses formulated, hypotheses that can be said to be confirmed.

We can start from the main hypothesis: technologies, due to their ability to generate interaction and their pervasiveness in the lives of children, are a privileged way forever more effective learning-teaching process.

This hypothesis is certainly confirmed, because the results of the final tests show that it has a high and significant percentage of students who have improved their performance (in terms of the average of the evaluations. To confirm the main hypothesis the results of the control group they present data that underlines how the performance of the students of the control group maintains a trend in line with the past.

In addition to this it is significant to note that by applying Cronbach's alpha, the calculated value shows that one can speak of reliability and reproducibility over time of the intervention as far as the experimental group is concerned.

For the control group, Cronbach's alpha detects the unreliability and reproducibility of the intervention, clearly linking the results to

strong influences both individual's capacity and of the environment from which he comes, without detecting a significant intervention of the process teaching.

Similarly, in relation to the experimental group, the secondary hypotheses can be considered verified, considering the data that highlight the ability to use the tools and the ability to face and solve technical and logical problems, both individually and in groups.

Similarly, the results of the final verification tests, seeing excellent results both in terms of evaluation and communication of the contents (see Annex A.5.) Confirm that technological skills are transformed into cognitive abilities, making both the capacity for synthesis and the ability to grow analytical skills.

VI.3. Reflections on empirical research

The comparison between the pre and post intervention data (see Figures no. VI.9. and no. VI.11.) in terms of modification of the scores achieved by the control group and the experimental group can be said to have been verified.

As will be discussed extensively in the conclusions, we see how the control group substantially maintained the previous performance and the statistical data show the non-existence of a correlation between method and results.

Instead, the experimental group highlighted an improvement in student performance with a correlation and repeatability of the method.

Empirical research has been important to understand the effectiveness of the use of integrated technologies in teaching learning processes.

The data collected to improve the results in the verification tests of learning have highlighted the importance of tools and methodologies that help the understanding of the knowledge structure that we want to learn.

The technologies are certainly not absent from the teaching methods of the teachers, but transmission technologies can be defined, which make it possible to "archive" everything that is taught but are oriented towards teaching.

Empirical research has shown that when talking about teaching processes, dealing with learning-teaching does not only mean putting two terms in relation but highlighting the focus, the perspective in which to act.

The technologies have proved useful in two specific directions:

- the search for the structure of knowledge for a better understanding;
- the use of technologies to experiment, but with a view to developing problem solving methods, learning to learn.

Speaking of learning-teaching means paying attention, as has been done in empirical research, to learning processes, focusing on the student and his dynamics with which he relates to learning.

Learning by mistake, building methodologies applicable not only to different technologies but also to different knowledge, allows us to say that empirical research has highlighted the possibility and effectiveness of integrating technologies in learning-teaching processes such as empowering and enhancing styles cognitive.

The technologies, whether they are software or hardware, whether they allow the development of analytical knowledge tools or the reinforcement of proactive approaches to knowledge, are the key to a training that becomes the students' ability to be in continuous training.

Although it was not among the objectives of empirical research, seeing and observing the boys work and the results they have achieved is important to highlight how this enhances the perspective of the flipped classrooms.

Flip teaching is a teaching methodology that has been spreading positively in recent years, especially in the school world.

We intend to invert a learning-teaching method supported by digital contents where times and working patterns are reversed with respect to traditional methods.

The flipped model the first moment consists of autonomous learning by each student, where the use of multimedia tools and interactive technologies are particularly effective and productive, which takes place outside the classrooms.

The second moment requires that the hours of classroom lessons be used by the teacher to carry out a personalized teaching strongly oriented to putting into practice the previously learned knowledge, where the collaboration and cooperation of the students are aspects that take on centrality.

In a world where information is more and more, always faster and "more fluid" and where students find themselves having more and more stratified knowledge, empirical research has shown, or at least highlighted the positivity, of the use of technologies not only as aids but as tools for increasing learning skills.

Experimentation in middle school has taken on greater significance because among the objectives of this school cycle there are those of building and increasing students' capacity for analysis and synthesis.

To deepen the reflections at the end of the intervention program it is important to note the difference in the level of learning achieved by the two groups.

We can reflect on the extent to which they have been learned from the historical-social and scientific contents of the control group and the experimental group.

The experimental group not only showed an improvement in academic performance (measurement through periodic classroom checks). By analogy, the control group not only failed to show relevant improvements in the level of learning (of the ability to understand the

presented topics in a structural way) but also Cronbach's Alpha highlighted that there is no expectation of repeatability of results.

This comparison and the results demonstrate that the working hypotheses have been verified, namely: the use of technologies in integrated learning-teaching processes increases the level of learning the increase in the level of learning, as the correlation of data demonstrates, is closely linked to the use of technologies in learning-teaching processes.

These technologies with interactivity, measured by the high level of exchange of information and actions between student and tools

it has encouraged and increases student participation, as noted by the questioner, and the formation and acquisition of knowledge, as noted by the results of the verification tests.

The abilities of synthesis and analysis are the result of the accessibility of educational technologies that, by promoting and improving the inclusive dimension of teaching processes, generate processes of information exchange, which are optimized with the skills of analysis and synthesis induced.

It underlines how the tests of the arguments, developed also through tools of communication of knowledge (infographics), have highlighted how the accessibility of the teaching tools implements the satisfaction of the students, giving an impulse to the "pleasure" of knowledge as an intrinsic improvement of the person. developing analytical and synthesis skills.

The technology integrated in the teaching processes acts effectively allowing a significant development of both the learning skills and the metabolization of knowledge.

CONCLUSION

General reflections

The research work originated from the need to reflect on the improvement of learning-teaching processes.

The reflection was born from trying to understand if, the technology, whose negative influences have always been mainly highlighted, could be re-evaluated within formal training environments, in relation to the fact that in non-formal and informal environments it had a big impact also in relation to the diffusion of social systems.

In formal environments the hypothesis that the use of technologies could increase the level of learning arises from having detected, through an exploratory research on middle school teachers, that technology had changed cognitive styles, but that these changes could be well integrated into the learning-teaching processes improving the level of learning.

By setting up the work, it seemed important to understand what could be some indicators that made the technology significant to increase the level of learning, inserting it into the teaching learning processes.

It was therefore decided to use as indicators that well described an effective use of technologies, of which measuring instruments were present and which were supposed to be connected with the development of the level of learning.

The increase in the level of measured learning, through the results obtained in the verification tests and correlated to the previous results (both, experimental group and control group) was found to be closely linked to the use of technologies in the learning-teaching processes.

The interactivity indicator, measured by the high level of exchange of information and actions between student and tools it has encouraged and increases student participation, as noted in the questionnaires, and the training and acquisition of knowledge, as noted by the reluctant verification tests.

The abilities of synthesis and analysis are the result of the accessibility of educational technologies which, by promoting and improving the inclusive dimension of teaching processes, generate processes of information exchange, which are optimized with the skills of analysis and synthesis induced.

It underlines how the tests of the arguments, also developed through knowledge communication tools (infographics), have shown how the accessibility of the teaching tools implements the satisfaction of the students, giving an impulse to the "pleasure" of knowledge as an intrinsic improvement of the person.

All the measurements made through questionnaires and observations have correlated the technologies to the attitudes aroused and generated in the class group, I become a learning community.

At the end of this arduous and limited journey of study and research it is interesting to look back to write a reflection on the structure of the research work and try to define a conclusion.

But, as we often find ourselves to be difficult to reach conclusions and if it is a question of reflecting on pedagogical processes, cognitive styles and the relationship with the reality that surrounds us in mode we could refer to the Maxim of Matz, written in the book of scientific semi-paradoxes "The law of Murphy" by the writer Arthur Bloch: "The conclusion is the point where you are tired of thinking".

In particular, the reflection on the relationship between technologies and their use in educational processes has revealed how the "playful" dimension together with technologies, therefore two dimensions inherent with people, can be a key to development and innovation that starting from the technologies can be introduced in formal learning environments.

By structuring the theoretical part, I became convinced of the conviction that the keystone is certainly the dimension of computational thinking, which the advent of technology has brought to the surface, but which is an inferential engine for cognitive processes.

By computational thinking, we mean a mental attitude, a mental process that allows problems of various kinds to be solved by following specific methods and tools.

So far, the definition of computational thinking.

Let us try to better understand the meaning of this definition. Substantially Computational thinking, briefly, is the ability to solve a problem by planning a strategy.

As the American scientist, Jeannette Wing explains, it means, "thinking like a computer scientist, in an algorithmic way and at multiple levels of abstraction".

Where by computational thinking we mean a logical-creative process that allows breaking down a complex problem, both practical and logical, different parts, more easily managed.

Finding a solution to each part of a problem it is possible to solve the general problem and by understanding the elements of a concept and their relationships, it is possible to understand the concept and elaborate metacognition processes.

Experimental program and interactivity of technologies ((hypothesis 1)

The real benefit, effective and characterizing technology is interactivity.

Interactivity is also one of the privileged means of introducing technologies through game methods and challenges that prove to be successful in the learning-teaching processes.

The experimental program has verified, in all its components, interactivity as an essential feature of effective technologies in teaching learning processes.

Using these technologies to link them to learning purposes but even more to the need to communicate what has been learned has increased students' ability to interact with technologies in a dimension and style of play.

The study of the use of technologies in learning-teaching processes also made me focus on coding as a "training ground" for cognitive thinking, but above all it brought out the conviction that the logical-creative dimension can be made to grow by incorporating technologies teaching with a playful interpretation key, which technologies facilitate.

In the theoretical study I did, I came to see as paradigmatic the dimension of the game that I see from this study as the evolution of the undoubted value of learning technologies.

The game is certainly, among human activities, a field of deep interest, a field that he has seen scholars and thinkers from philosophy to psychology.

The game has aroused debates and studies that have seen psychologists, sociologists, ethologists, biologicals and anthropologists confront each other, involving, in time, more and more actively the educationalists.

When dealing with the theme of the game, the thought certainly moves Gregory Bateson who has been interested in the game from the point of view of a complex trans-contextual[1] path, where the game for human beings, but the concept can be extended to living beings, is propaedeutic to understanding and to act accordingly by determining if a behavior is a game or a threat.

---

[1] See Cfr. Bateson, G. (1996). *Questo è un gioco - Perché non si può mai dire a qualcuno "gioca!"*. Milano: Raffaello Cortina Editore

In this reflection and with a view to using the game in teaching it is interesting to recall a further definition of Bateson, when he states that "the game and the creation of the game must be seen as a single phenomenon and indeed, from the subjective point of view, it is plausible to say that the sequence can really be played only as long as it retains some creative and unexpected element.

If the sequence is completely known, it is repeatable, though perhaps still formative of the character "[2].

It can therefore be said, again with Bateson, and reflecting in a learning perspective that "the term play does not limit or define the acts that make up the game. (...) In ordinary language, "game" is not the name of an act or an action: it is the name of a frame for action. We can expect then that the game be not subject to the regular rules of reinforcement.

Indeed, anyone who has tried to make children stop playing knows what it feels like to see their efforts simply being incorporated into the structure of their game"[3].

Surely, and it is in the experience of each of us, play as a communicative mode is inherent in nature, a way that allows us to learn, using experience, and transforming error into learning.

Experimental program: usability and accessibility (hypothesis 2 and 3)

Accessibility and usability have been joined because both in the "common feeling" and from the point of view of the influence that they have correlated with the intervention program they represent an interconnected entity.

The intervention program meant that the intrinsic accessibility of the technologies was increased by the strong interaction between the

---

[2] Bateson, G. (1988). Mente e natura. Milano: Adelphy.

[3] There, pg. 85.

students. The fact that the technologies and tools that implement them are easily usable by any user has been verified with the questionnaires. However, the intervention program has increased accessibility through the system of learning communities that technologies have generated.

The intervention program has certainly taken advantage of the usability understood as effective, efficiency and user satisfaction.

Now efficacy and efficiency have certainly been developed in consideration of verified learning outcomes, which are also the result of a learning community born of these characteristics.

But of fundamental importance is the satisfaction that was measurable not only by the positive results obtained but also by the observation of how the boys did not feel as an "imposition" the study developed also with the technologies.

Also, these last considerations refer to the dimension of the game as a methodology of perspective, where effectiveness, efficiency and satisfaction are functional to the achievement of a purpose. Use the game as a method, a game that includes the game itself and its creation allows you to confront concepts and rules, which can then be reflected in real life; the development of rules and the strong motivational impact make play an important aid to effective learning.

As we often find ourselves to be difficult to reach conclusions and if it is a question of reflecting on pedagogical processes, cognitive styles and the relationship with the reality that surrounds us in a "playful" way we could refer to the Maximum of Matz, written in the book of semi-paradoxes "The Law of Murphy" by the writer Arthur Bloch: "The conclusion is the point where you are tired of thinking".

But it is exactly what we do not intend to do, we started from computational thinking precisely because it allows us to develop abstraction tools for a continuous understanding and interaction with reality in the style of Resnick's creative spiral.

Even in this context, technologies can make humanity re-emerge and play as a learning style finds both in robotics and in coding a habitat in which to develop all its potential that educational processes must make their own.

A path was highlighted in which the correlations between coding, computational thinking, educational robotics and play generate a synergy that in the game-learning dualism sets some of its founding bases.

We are aware that all the actors of the didactic-educational processes that care about the harmonious growth of people, teachers, trainers and parents, and are coaches of brains and feeders of emotions; the game favors the affective, cognitive and social development, beyond any theory that is shared.

The game is emotion, ethics, learning and teaching and without these tensions there cannot be a significant educational relationship; we cannot therefore ignore the value of technologies supporting this relational and educational fabric.

It must not be forgotten that certain attentions and methodologies are inherent in man and must be cultivated with the tools that evolution and scientific and social progress make available to us.

If, in the common meaning, the meaning of the word "game" has a completely different connotation, if not antithetical with respect to "serious", we recall what Michel De Montaigne, French philosopher and writer of the sixteenth century stated: "Children's games do not they are games, and they must be considered as their most serious actions "and this can probably be said of any age in life.

The value of the game is confirmed and emerges in several researches and its priority must be considered by parents and teachers.

There is a direct proportionality between the awareness, involvement and recognition by parents and teachers in play activities and the role they play in processes that promote learning.

In this context, the fundamental role of guided play emerges which parents and teachers, but in general the world of adults becomes fundamental.

The child, the boy remains the center of the activity, but the adult world has the task of defining the educational objectives and the didactic objectives.

The adult, who plays the role of guided play monitors, directs and animates, where necessary, the playful activity, and guided play has been highlighted by various researches to be a very effective strategy in teaching-learning processes.

We can therefore note that we are in the perspective of the game concept that evolves and is assigned a new role, different from that of an activity, with amusing contours and entertainment with mainly recreational intentions, and that in competitive contexts, ludus, they are defined through purposes and rules; from the etymological game, from the Latin iŏcus, with the meaning of joke, joke, to play as an object of study, a fundamental tool in the growth and development of people and their abilities.

It is therefore possible to conclude briefly by recalling also how the game abstained from being object of philosophical, sociological and psychological reflection, thus giving a picture that highlights its importance and recalls its trans-contextual dimension, as recalled by Bateson, and that is "*a) that the messages or signals exchanged in the game are in a sense not true or are not the ones you have in mind; and b) that what is denoted by these signals is non-existent*".

For a final multidisciplinary framework, it is interesting to note how Aristotle combined play with joy and virtue; he writes in the *Nicomachean Ethics* that "there are activities that deserve to be chosen for themselves, not for anything else, like happiness" and among them he cites the game.

But the history of philosophy thinks about the game and reflects and in particular it is interesting to remember the Dutch philosopher Johan Huizinga, who in his treatise Homo ludens, written in 1938, focuses on the game as a complex cultural system "[...] this does not mean that the game changes or converts into culture, but rather that culture, in its original phases, carries the character of a game; it is represented in playful forms and moods: in this duality - unity of culture and play, play is the primary fact, objective, perceptible, concretely determinable; while culture is nothing but the qualification applied by our historical judgment given to chance".

As we often find in this it is difficult to reach conclusions and if it is a question of reflecting on pedagogical processes, cognitive styles and the relationship with the reality that surrounds us in a "playful" way we could refer to the Maximum of Matz, written in the book of semi-paradoxes "The Law of Murphy" by the writer Arthur Bloch: "*The conclusion is the point where you are tired of thinking*".

But it is exactly what we do not intend to do, we started from computational thinking precisely because it allows us to develop abstraction tools for a continuous understanding and interaction with reality in the style of Resnik's creative spiral.

Even in this context, technologies can make humanity re-emerge and play as a learning style finds both in robotics and in coding a habitat in which to develop all its potential that educational processes must make their own.

A path was highlighted in which the correlations between coding, computational thinking, educational robotics and play generate a synergy that in the game-learning dualism sets some of its founding bases.

We are aware that all the actors of the didactic-educational processes that care about the harmonious growth of people, teachers, trainers and parents, and are coaches of brains and feeders of emotions;

the game favors the affective, cognitive and social development, beyond any theory that is shared.

The game is emotion, ethics, learning and teaching and without these tensions there cannot be a significant educational relationship; we cannot therefore ignore the value of technologies supporting this relational and educational fabric.

It must not be forgotten that certain attentions and methodologies are inherent in man and must be cultivated with the tools that evolution and scientific and social progress make available to us.

If, in the common meaning, the meaning of the word “game” has a completely different connotation, if not antithetical with respect to “serious”, we recall what Michel De Montaigne, French philosopher and writer of the sixteenth century stated: “Children's games do not they are games, and they must be considered as their most serious actions “and this can probably be said of any age in life.

This is why the theoretical study makes me aware of the importance of technology in educational processes and has led me to imagine a deepening in the direction of computational thinking and in the revaluation of the playful dimension in the school and not exclusively as leisure but with an important educational value and cognitive and relational development; a technology that in developing tools seeks to recover the deep roots of man's relationship with knowledge and consequently with the reality that surrounds him.

Reflections on research limit and perspectives

The experimental project has certainly achieved the objectives set, the use of technologies allows increasing the level of learning and above all has highlighted how in this way the students understand the relationships between the concepts they learn and the tools they use.

The limitation of this experimentation is that it was carried out in an "optimal" environment with able-bodied students, on average supported by families of media culture and without obvious relationship problems.

Despite this success in experimentation, it is necessary to think, in perspective, of teacher training not so much for the use of specific technologies, but for a continuous analysis of technologies to understand their potential, their influence on children and the way better to educate them on the use of the technologies themselves.

In the information society and in the stratification of knowledge that we face we must imagine tools that allow us to extract the fundamental concepts that interest us; this means learning to ask questions and learn, have the competence to give the right weight and the right place in the logical structure to the answers.

If we go to review how technological development is described, comparing the work of the three most important scholars in this context Lewis Henry Morgan (1818-1881), who with Edward Burnett Tylor is the founder of cultural anthropology and by anthropologists Leslie Alvin White (1900-1975), Gerhard Lenski (1924-2015), lived in different eras, we will find that seven epochs are imagined:

- Nomadic hunter-gatherers
- Age of nomads
- The first era of the machine
- The beginning of production in "quantity"
- The full development of the steam age
- Propagation of the internal combustion engine
- Electric and electronic age

Now we must imagine teaching and preparing teachers to teach in the ***information age***.

The three experimental phases have, in addition to confirming the effectiveness of the use of technologies in teaching with those playful

dimensions and the development of computational thinking highlighted above, emphasizing the need to continue working on the analysis of cognitive styles.

For this reason, the research has considered the possibility of a project that intends to focus on issues related to the analysis of cognitive fields and cognitive modifiability.

Habits, in fact, are "cognitive paths", experimental models of behavior with which we relate to the world, are learning patterns that presuppose visual points. These paths outline the limits and potential of the cognitive field.

However, it is also true that they are likely to change, expand, interconnect, restructure or disappear with the activation of other fundamental knowledge. In fact, the fundamental, basic knowledge that the school builds with its protagonists makes sense if all the subjects involved in the training game are aware that, while they build a knowledge, they activate a series of acquisitions that they will use, at least in part, in other contexts.

These are metacognitive learnings. When we talk about cognitive functions, we refer to basic cognitive and coordination processes.

Among the basic cognitive processes, we consider the following: perception, emotion, attention, memory, language (breadth and plurality of vocabularies, mastery and precision), and empathy.

Among the coordination ones, we consider the following: plurality of linguistic styles and interaction, visual-spatial and topographical orientation, practicality and practicality, abstract thinking, intuition, creativity, cognitive self-awareness.

The objectives of this project are to provide answers to the fundamental questions in relation to the issue:

- *What are the well-developed cognitive functions, and which are lacking based on standard paradigms recognized by literature?*

- *What are the emotional problems that hinder the execution of a task or learning?*
- *Which processes facilitate it?*
- *What strategies for potential cognitive functions?*
- *What is the extent of the improvement we can expect?*
- *What are the linguistic and relational assumptions that can trigger change?*

On the one hand, we will analyze the critical issues detected in adolescents' cognitive approaches (concentration difficulties, attention, abstraction, motivation, synthesis, solipsistic behaviors).

On the other hand, we will show how a conscious use of cognitive approaches helps teachers to analyze the cognitive habits and therefore, the difficulties, the strengths of their students, as well as to activate a metacognitive approach to school knowledge.

The activities that the project will implement, after a preliminary bibliographic research on the international debate, foresees the analysis in a systemic perspective of the following fundamental elements that characterize the structure of a cognitive field:

- *the ability to identify the relationships between the part and the whole of a context;*
- *the proposal of exercises that have a clear metacognitive depth, that is, that do not aim exclusively at training specific functions, but rather that, at the same time, develop similar or close functions, i.e. that activate a structural change in the child;*
- *the ability to identify the virtuous relationship between training needs and school proposals.*

To this end, questionnaires will be prepared, structured and semi-structured interviews to be submitted to a significant sample of teachers and students.

The methods that the project, born from the work of this thesis, can be described as a qualitative approach.

The relationships between data and information will be analyzed in a systemic perspective. However, the numerical and statistical aspects of data and information will also be analyzed.

We are convinced that an intelligent consideration of quantitative data leads to considerations and hypotheses of a qualitative nature, but the opposite is also true.

The strategies of the project that takes its cue from the research carried out involves the analysis of salient cases collection, cataloging, analysis of experiences, data and information.

Action research with teachers and students: the internalized action, or accompanied by the competent guide of the teacher, becomes a mental operation.

The boy learns the procedural sense as well as the different strategies that, in other contexts, this procedure can activate.

This event shows us that it is possible, on the one hand, to study the guidelines of a cognitive field, on the other, to improve its mental capacities. The metallization of a procedure, an operational choice, a strategy aimed at solving a problem, implies the competence of the teacher in guiding the reflection on the evidences, on the gestures, on the operations. In this way, it is possible to correct the structure of the cognitive functioning, rework the schemes of action, and improve their criticality.

In a word: to increase learning potential.

The teacher learns about the cognitive habits of his students, identifies the resources with weaknesses, and uses the error as a concrete opportunity for strategic rethinking.

The epistemology that will continue to characterize the project is composed of interpretative pedagogy, narrative pedagogy, and hermeneutics.

This knowledge is not based on the possibility of an exchange, of their mutual aid and therefore on the synergistic action of different styles of thought, cognitive approaches, intelligences.

The unity of signification, the epistemic nexus, and the eidetic structure is the relationship,

The adopted epistemic values establish and elaborate a hierarchy of criteria aimed at justification, or rather at the consequentiality of our theory of knowledge in relation both to its applications and to the theoretical and methodological premises.

An epistemological perspective of a hermeneutical character emerges from the foregoing.

The network of structures is organized in an elastic, dynamic, highly integrated and, at the same time, open hierarchy.

It is an organizational framework of the knowledge with which we interpret and build; therefore, it has an active and concrete tension. Active, because it acts on the real and regards both the processes, the acquisition, the construction, the organization of cognitive data.

In addition, it is concrete, because it refers to the way we see the world, to the questions we ask ourselves when we act and that direct our conduct, concerns the hypotheses of our research and its procedures.

The research carried out so far has also highlighted the need to proceed with an interdisciplinary project, the disciplines involved are:

- Pedagogy, in its epistemological and experimental aspects;
- Philosophy of education.

The verification of the project involves a rigorous process analysis of the following fields according to the criterion of their mutual consistency as well as the consistency between methods, activities, tools, epistemology and objectives.

Verification and analysis fields are:

1. *the processes of construction, organization, dissemination and transformation of knowledge;*
2. *the methods, the contexts of meaning and the conditions of their construction;*

3. *the conditions, in turn, pose the problem of the verifiability of such constructions (for example: when and to what degree does a knowledge possess criteria of truth, certainty and effectiveness?).*
4. *the choice of information that experience suggests to us, their interpretation and their placement within our knowledge system;*
5. *the relationship of these processes with our cognitive self, or with the conscious and non-conscious perception, that we have both of our cognitive field and of our potentialities of acquisition, elaboration, invention;*
6. *specific language of the disciplinary approaches involved, field of study and application, peculiarity of the contents, method, procedures, theoretical background, consequentiality, verifications, tools and coherence of the relations of meaning and procedure that exist between them.*

The evaluation criteria will consider the following points:

- *the parameters based on which we evaluate the impact that these problems have on the present;*
- *the epistemological assumptions even those implicit in the procedures;*
- *methodological consistency with these assumptions;*
- *conceptual tools, the theoretical background in the international debate;*
- *the theories of reference;*
- *the criteria for a constant revision of the model and its strategies;*
- *the means of observation, collection, cataloging and documentation;*
- *the tools for verifying and evaluating the results of our research in relation to the objectives, assumptions and means we have been able to use;*
- *the coherence between all these elements and the possibility of re-arranging them.*

It can therefore be stated that in the verification of the hypotheses defined both for the theoretical part and for the practical part, the path of the analysis of cognitive styles and of the hermeneutical interpretation of technologies has been undertaken as they are configured and modified.

The project may seem ambitious, and perhaps it is, but we intend to work in perspective and with the spirit that the Japanese-born American physicist Michio Kaku described in this way: "*When an important but elderly scientist state that something is possible, he is almost always right. When he says of something that is impossible, he is probably wrong. The only way to discover the limits of what is possible is to go a little further and venture into the impossible. Any fairly advanced technology is indistinguishable from magic*".

REFERENCE

ABRAMI, P. C., BERNARD, R.M. BOROKHOVSKI, E., WADDINGTON, D. I., WADE, C. A. and PERSSON, T. (2015). Strategies for Teaching Students to Think Critically: A Meta-Analysis. in Review of Educational Research, vol. 85, nº 2, 1º giugno 2015, pp. 275-314.

ALLEN D.W, RYAN, K.A. (1969), Microteaching Reading Mass: Addison Wesley.

ANTONIETTI A., CANTOIA M. (2000). La mente che impara. Percorsi meta cognitivi di apprendimento. Firenze: La Nuova Italia.

ANTONIETTI A., CANTOIA M. (2000). La mente che impara. Percorsi meta cognitivi di apprendimento. Firenze: La Nuova Italia.

ARDIZZONI P., RIVOLTELLA P.C. (2009). Media e tecnologia per la didattica. Milano: Vita e Pensiero.

BALDASCINO R. (2015). Insegnare ed apprendere in un mondo digitale. Napoli: Tecnodid.

BARBIER R., (2007). La ricerca-azione, Roma: Armando.

BATESON, G. (1988). Mente e natura. Milano: Adelphy.

BATESON, G. (1996). Questo è un gioco - Perché non si può mai dire a qualcuno "gioca!". Milano: Raffaello Cortina Editore.

BERTHELSEN D., BROWNLEE J., JOHANSSON E. (2012). Participatory Learning in the Early Years: Research and Pedagogy. Brampton: Routledge.

BIONDI G., a cura di (2008). LIM. A scuola con la lavagna interattiva multimediale. Nuovi linguaggi per innovare la didattica. Firenze: Giunti Editore.

BOWER M. (2017). Design of Technology-Enhanced Learning. Bingley (UK): Emerald Group Publishing.

BROUSSEAU G. (2006a). Epistemologia e didattica della matematica. La matematica e la sua didattica. 4, 621-655.

BROUSSEAU G. (2006b). Epistemologia e formazione degli insegnanti. In: Sbaragli S. (ed.) (2006). La matematica e la sua didattica, venti anni di impegno. Atti del Convegno internazionale omonimo. Castel San Pietro Terme, 23 settembre 2006. Bologna: Pitagora. 54-58. Pubblicato inoltre su: D'Amore B. (ed.) (2006). Matematica: l'emergenza della didattica nella formazione. Numero speciale monotematico di Rassegna. 29, 29-33.

CAILLOIS, R. (1981). I giochi e gli uomini. Milano: Bompiani.

CALIDONI P., GHIACCIO M. F. (2015). Viste da vicino. Dinamiche e criticità dell'innovazione digitale nella didattica. Casi e indicazioni da esplorazioni sul campo. Lecce: Pensa Multimedia.

CAMPIONE V., a cura di (2015). La didattica nell'era digitale. Bologna: Il Mulino.

COHEN L., MANION L., MORRISON K. (2000). Research Methods in Education. London: Routledge/ Falmer.

CONVERTINI, V. C., ALBANESE, D., MARENGO, A., MARENGO, V., & SCALERA, M. (2006). The OSEL Taxonomy for the classification of Learning Objects. Interdisciplinary Journal of Knowledge and Learning Objects, 2, 125-138.

CONVERTINI, V. C., ALBANESE, D., MARENGO, A., MARENGO, V., & SCALERA, M. (2006). The OSEL Taxonomy for the classification of Learning Objects. Interdisciplinary Journal of Knowledge and Learning Objects, 2, 125-138.

COSENTINO A. (2002). Costruttivismo e formazione. Proposte per lo sviluppo della professionalità docente. Napoli: Liguori.

CUSSINS A., Content, embodiment and objectivity: The theory of cognitive trails, in Mind, 101-404, October 2002.

CRAIG D. F. (2018). Educación 4G - BYOD - Trae tu propio dispositivo: Una propuesta para aprovechar las posibilidades pedagogógicas de los celulares y tablets con internet 4G en la educación secundaria y superior. Independently published.

DAFFY T. (2012). Designing Environments for Constructive Learning. Berlino: Springer.

DAMIANO E. (2005). La ricerca didattica oggi, comunicazione al conv. naz. della SIPED tenuto a Macerata il 26 e 27 maggio 2005.

DAMIANO E., La ricerca didattica oggi, comunicazione al conv. naz. della SIPED tenuto a Macerata il 26 e 27 maggio 2005.

DANIELA L. (2018). Innovations, Technologies and Research in Education. Cambridge (UK): Cambridge Scholars Publishing.

DANIELA L. (2019). Didactics of Smart Pedagogy. Smart Pedagogy for Technology Enhanced Learning. Berlino: Springer.

DEWEY J. (1938). Unity of Science as a Social Problem. Chicago: University of Chicago Press.

DE MAURO A., GRECO G., GRIMALDI M. (2015). What is big data? A consensual definition and a review of key research topics. AIP Conference Proceedings, vol. 1644, 2015, pp. 97–104.

DE MAURO A., GRECO G., GRIMALDI M. (2015). What is big data? A consensual definition and a review of key research topics. AIP Conference Proceedings, vol. 1644, 2015, pp. 97–104.

DEY A. (2001). Understanding and Using Context. Journal Personal and Ubiquitous Computing archive, 5, 1, February. Atlanta: College of Computing & GVU Center, Georgia.

DEY A., ABOWD G., SALBER D. (2001). A conceptual framework and a toolkit for supporting the rapid prototyping of context-aware applications. Human-Computer Interaction. Hillsdale: L. Erlbaum Associates Inc.

GARDNER H., (1994). Intelligenze multiple, traduzione dall'inglese di I. Blum, Milano: Edizioni Anabasi.

GIBSON J. (1950). The perception of the visual world. Cambridge: Riverside Press.

GRAMIGNA A. (2015). Dinamiche della Conoscenza. Epistemologia e prassi della formazione. Roma: Aracne.

GRAMIGNA A., (2012). Epistemologia della formazione nel presente tecnocratico. Milano: Edizioni Unicopli.

GRIMALDI R. (2015). A scuola con i robot. Innovazione didattica, sviluppo delle competenze e inclusione sociale. Bologna: Il Mulino.

HUIZINGA, J. (1946). Homo ludens. Torino: Einaudi.

JENKINS H. (2006). Convergence culture: where old and new media collide. New York: University Press.

LAUREL, B. (1993). Computer as Theatre. Boston: Addison-Wesley Professional.

LAVE J., WENGER E. (1990). Situated Learning: Legitimate Peripheral Participation. Cambridge: University Press.

LUGMAYR A. (2007), Ambient Media, Novatica, vol. 33, pp. 35-39, July-August (http://www.ati.es/novatica/infonovatica_eng.html).

MANYIKA J., CHUI M, BUGHIN J., BROWN B., DOBBS R., ROXBURGH C., HUNG BYERS A (2011). Big Data: The next frontier for innovation, competition, and productivity. Report McKinsey Global Institute.

MARCIANÒ G. (2017). Robot & scuola. Guida per la progettazione, la realizzazione e la conduzione di un Laboratorio di Robotica Educativa (LRE). Milano: Hoepli.

MCEWEN A., CASSIMALLY H. (2014). L'Internet delle cose. Milano: Apogeo.

MCKENZIE J. (2019). Transmedia Knowledge for Liberal Arts and Community Engagement. Palgrave Pivot.

MIMI I., MATTEI M.G., edited by (2015). Apprendere digitale. Meet the media guru. Milano: EGEA - Università Bocconi Editore.

MITCHELL, T. (1997). Machine Learning. Milano: McGraw Hill.

Nell M. L. and Drew W. F. (2013). From Play to Practice: Connecting Teachers' Play to Children's Learning. Washington: National Association for the Education of Young Children.

NIND M., CURTIN A., HALL K. (2016). Research Methods for Pedagogy. Bloomsbury Academic.

NORMAN D. (1988). The Psychology of Everyday Things. New York: Basic Books.

PAPERT S. (1984). Bambini computer e creatività. Milano: Emme Edizioni.

PAPERT, A. S. (1980). Mindstorms: Children, computers, and powerful ideas. New York: Basic Books, Inc.

PIAGET, S. (1971). L'epistemologia genetica. Bari: Laterza.

PIAGET, S. (1971). Psicologia ed epistemologia. Per una teoria della conoscenza. Torino: Loescher.

PIZZALIS, M., PORCU, M., DE FEO A., GIAMBONA, F. (2016). Innovare la scuola. Insegnanti, studenti e tecnologie digitali. Bologna: Il Mulino.

RASKIN, J. (2003). Interfacce a misura d'uomo. Milano: Apogeo

REDEKER, G. (2003). An educational taxonomy for learning objects. IEEE International Conference on Advanced Learning Technologies.

RIVOLTELLA, P.C. (2010). A scuola con media digitali. Problemi, didattiche, strumenti. Milano: Vita e Pensiero.

RIVOLTELLA, P.C. (2017). Media education. Idea, metodo, ricerca. Brescia: Editrice La scuola.

ROTTA, M. (2015). Verso i GLOCs: un approccio sperimentale alla didattica situata e al pensiero critico. http://www.mariorotta.com/knowledge/

RUSHKOFF, D. (2006). Screenagers: Lessons in Chaos from Digital Kids. Cresskill N.J.: Hampton Press Communication.

SCURATI, C. ZANNIELLO, G. (1993). La ricerca-azione. Contributi per lo sviluppo educativo. Napoli: Tecnodid.

SCHÖN, D. (1983). The reflective practitioner. London: Temple Smith.

SITTA, E. (2016). La LIM in classe. Uno strumento per entrare nel mondo delle tecnologie e lavorare sul gruppo degli studenti. Torino: Elledici.

SPINELLI A. (2009). Un'officina di uomini. La scuola del costruttivismo, Napoli: Liguori Editore.

STROLLO, M.R (a cura di) (2008). Scienze cognitive e aperture pedagogiche. Nuovi orizzonti nella formazione degli insegnanti. Milano: Franco Angeli Editore.

THOMAS, M. (2011). Digital Education: Opportunities for Social Collaboration. Palgrave Macmillan.

TOSCHI, L. (2012). Realtà Aumentate: Esperienze, strategie e contenuti per l'Augmented Reality. Milano: Apogeo.

VARANI A., CARLETTI A., a cura di (2012). Ambienti di apprendimento e nuove tecnologie. Nuove applicazioni della didattica costruttivista nella scuola. Trento: Erikson

VARISCO, B.M. (2002). Costruttivismo socio-culturale. Genesi filosofiche, sviluppi psico-pedagogici, applicazioni didattiche. Roma: Carocci.

VON GLASERSFELD, E. (1998), Il costruttivismo radicale. Roma: Società Stampa Sportiva (Divisione Cultura & Scienze).

WENGER, E. (1998). Communities of Practice: Learning, Meaning, and Identity. Cambridge University Press

WILEY, D.A. (2000). Connecting learning objects to instructional design theory. A definition, a metaphor and a taxonomy. In D. Wiley (Ed.), The instructional use of learning objects, 1, 3-29 Bloomington. URL http://reusability.org/read/chapters/wiley.doc

WILSON, B. a cura di (1996). Constructivist Learning Environments. Case Studies in Instructional Design, Educational Tecnology Publication, Englewood Cliff, New Jersej.

VYGOTSKIJ S. L. (1978), Storia dello sviluppo delle funzioni psichiche superiori. Firenze: Giunti Editore.

WING, J. M. (2006). Computational thinking, in COMMUNICATIONS OF THE ACM, vol. 49, nº 3, 03-2006, pp. 33-35.

ANNEXES

A.1 Evaluation questionnaire on cognitive stills

Processi di costruzione della Conoscenza

Scopo del progetto è nella proposta di una scuola che miri alla valorizzazione dei talenti tanto degli insegnati quanto degli studenti.

* Required

1. **LIVELLO DEL TITOLO DI STUDIO** *
   Mark only one oval.
   - ◯ Diploma
   - ◯ Laurea
   - ◯ Dottorato di Ricerca (PhD)

2. **AREA DEL TITOLO DI STUDIO** *
   Mark only one oval.
   - ◯ Umanistica
   - ◯ Tecnico-Scientifica
   - ◯ Amministrativa-Legale

3. **SESSO** *
   Mark only one oval.
   - ◯ Maschio
   - ◯ Femmina
   - ◯ Non Risponde

4. **DATA di Nascita**

   Example: December 15, 2012

Area di Insegnamento

5. **SCUOLA IN CUI INSEGNA** *
   Mark only one oval.
   - ◯ Primaria
   - ◯ Secondaria di I grado
   - ◯ Secondaria di II grado

6. **DA QUANTO TEMPO INSEGNA** *
   Mark only one oval.
   - ◯ Meno di 5 anni
   - ◯ Da 5 a 10 anni
   - ◯ Oltre 10 Anni

7. **AREA DI INSEGNAMENTO** *

Mark only one oval.

- Umanistica
- Tecnico-Scientifica
- Amministrativa-Legale

VALUTAZIONE DEI TREND COGNITIVI

Negli ultimi anni i giovani sono stati oggetto di un bombardamento di informazioni e di stimoli molto rapidi che pare abbiamo reso difficile se non fastidioso vivere le situazioni che richiedono ritmi lenti. Ripensando alla sua esperienza di docente di questi ultimi anni quanto concorda con le seguenti affermazioni?

8. **Gli studenti hanno peggiorato la capacità di** *

Mark only one oval per row.

	Totalmente d'accordo	Parzialmente d'accordo	Né in accordo né in disaccordo	Parzialmente in disaccordo	Totalmente in disaccordo
individuare le differenze (ANALISI)					
classificare le differenze individuate					
elaborare integrazioni fra elementi differenti (SINTESI)					
stabilire degli insiemi di elementi in base al principio dell'affinità o della congruenza					
codificare e decodificare un messaggio, un linguaggio, un codice, un'istruzione, un programma...					
individuare parole chiave che connotassero un evento o un processo					
individuare le relazioni fra la parte e il tutto di un contest					
attivare comportamenti sociali collaborativi e solidali					

9. **Nel complesso, ripensando alla sua esperienza, in che misura concorda con la seguente affermazione?** *
Mark only one oval per row.

	Totalmente d'accordo	Parzialmente d'accordo	Né in accordo né in disaccordo	Parzialmente in disaccordo	Totalmente in disaccordo
La massiccia frequentazione nei confronti degli apparati tecnologici da parte di bambini e ragazzi ha esercitato un ruolo principale nel cambiamento del loro approccio all'apprendimento nelle dimensioni individuate nella precedente tabella di affermazioni	⬭	⬭	⬭	⬭	⬭

10. **La massiccia frequentazione nei confronti degli apparati tecnologici da parte di bambini e ragazzi ha esercitato un ruolo principale nel cambiamento del loro approccio all'apprendimento nelle dimensioni individuate nella precedente tabella di affermazioni**

____
____
____
____
____

A.2 Data collection questionnaire (research group students and control group students)

Dati Generali studente

* Required

1. **Classe Frequentata** *

   Mark only one oval.

   - ◯ Prima
   - ◯ Seconda
   - ◯ Terza

2. **SESSO** *

   Mark only one oval.

   - ◯ Maschio
   - ◯ Femmina

3. **Anno di Nascita** *

   ____

   Example: December 15, 2012

Dati sul nucleo famigliare

Livello di studi e tecnologie possedute

4. **Livello massimo di studi in famiglia** *

   Mark only one oval.

   - ◯ Nessun titolo
   - ◯ Licenza Elementare
   - ◯ Licenza media
   - ◯ Diploma di Scuola Superiore
   - ◯ Laurea
   - ◯ Dottorato di Ricerca
   - ◯ Other: ____________________

5. **Device e tecnologie disponibili in famiglia** *

   Check all that apply.

   - ☐ PC fisso
   - ☐ PC portatile
   - ☐ Tablet
   - ☐ Smartphone
   - ☐ Bookreader
   - ☐ Other: ____________________

Informazioni sulle tecnologe

A chi appartengono e come sono usate

6. **Quali delle seguenti tecnologie sono a tuo uso esclusivo** *

Check all that apply.

- [ ] PC fisso
- [ ] PC portatile
- [ ] Tablet
- [ ] Smartphone
- [ ] Bookreader
- [ ] Other: ____________________

7. **Per ciascuna delle tecnologie che utilizzi, indica per quali scopo la usi**

Check all that apply.

	Gioco	Vedere contenuti multimediali (film, canzoni, Youtube...)	Navigare e usare socialnetwork	Studiare	Per produrre contenuti (audio, video, testi...)
PC fisso	☐	☐	☐	☐	☐
PC portatile	☐	☐	☐	☐	☐
Tablet	☐	☐	☐	☐	☐
Smartphone	☐	☐	☐	☐	☐
Bookreader	☐	☐	☐	☐	☐

A.3 Data collection questionnaire (research group students): opinion on the H5P environment

Come valuti l'ambiente di sviluppo H5P

* Required

1. **Difficoltà rilevate** *

   Check all that apply.

   - [ ] Nessuna
   - [ ] Interfaccia troppo complessa
   - [ ] Difficoltà con la lingua dell'interfaccia (Inglese)
   - [ ] Comandi e menu che non sono comprensibili
   - [ ] Gestione dei contenuti (formati accettati, grandezza dei file,...
   - [ ] Other: ________________

2. **Come hai affrontato/risolto le difficoltà rilevate** *

   Check all that apply.

   - [ ] Non ho superato le difficoltà
   - [ ] Ho provato da solo (tentativi)
   - [ ] Ho chiesto all'insegnante
   - [ ] Ho chiesto aiuto ai mie compagni

3. **Quali sono gli strumenti che hai usato di più nell'ambiente H5P** *

   Check all that apply.

   - [ ] Video interattivo (Interactive Video)
   - [ ] Time Line
   - [ ] Virtual Tour 360°
   - [ ] Libro interattivo (Interactive Book)
   - [ ] Memory Game

4. **Come valuti l'ambiente rispetto alle seguenti caratteristiche (0 pessimo - 4 ottimo)**

   Mark only one oval per row.

	0	1	2	3	4
Livello di interattività	◯	◯	◯	◯	◯
Media diversi utilizzabili	◯	◯	◯	◯	◯
Facilità di lettura dei contenuti	◯	◯	◯	◯	◯
Comprensione dei contenuti	◯	◯	◯	◯	◯
Comprensione della struttura dei contenuti	◯	◯	◯	◯	◯

Powered by Google Forms

A.4 Data collection questionnaire (research and control group students): opinion on Arduino

Come valuti il sistema ARDUINO

* Required

1. Difficoltà rilevate *

Check all that apply.

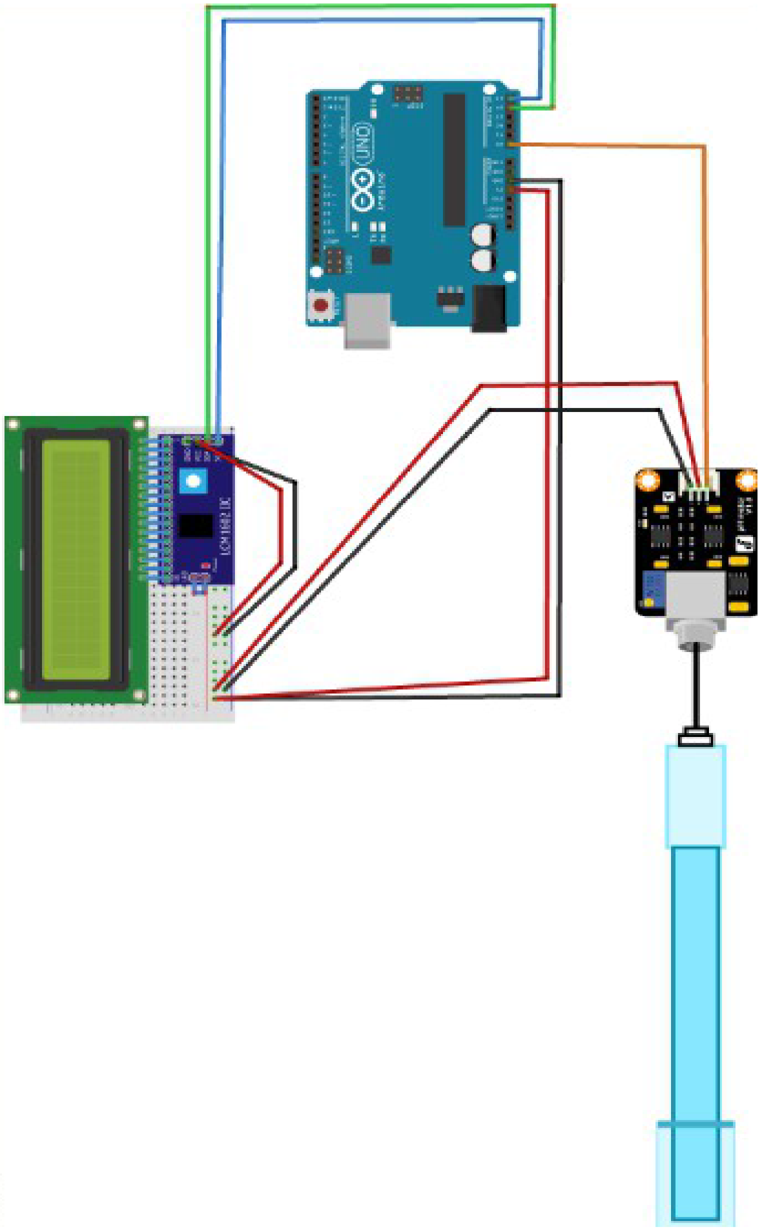
- [ ] Nessuna
- [ ] Interfaccia troppo complessa
- [ ] Problemi nell'assemblaggio dei componenti
- [ ] Problemi di comprensione della programmazion
- [ ] Difficoltà nell'utilizzo dei sensori e della loro gestione
- [ ] Other: ____________________

2. Come hai affrontato/risolto le difficoltà rilevate *

Check all that apply.

- [ ] Non ho superato le difficoltà
- [ ] Ho provato da solo (tentativi)
- [ ] Ho chiesto all'insegnante
- [ ] Ho chiesto aiuto ai mie compagni

A.4 Scheme of the circuit Arduino used in practical experience



A.5 Jars containing the solutions to evaluate the pH



In the order ***Vinegar****,* ***Lemon*** *and* ***Pear Juice***



In the order **Vinegar +** *red cabbage juice*,
Lemon+ *red cabbage juice* and **Pear Juice+** *red cabbage juice*

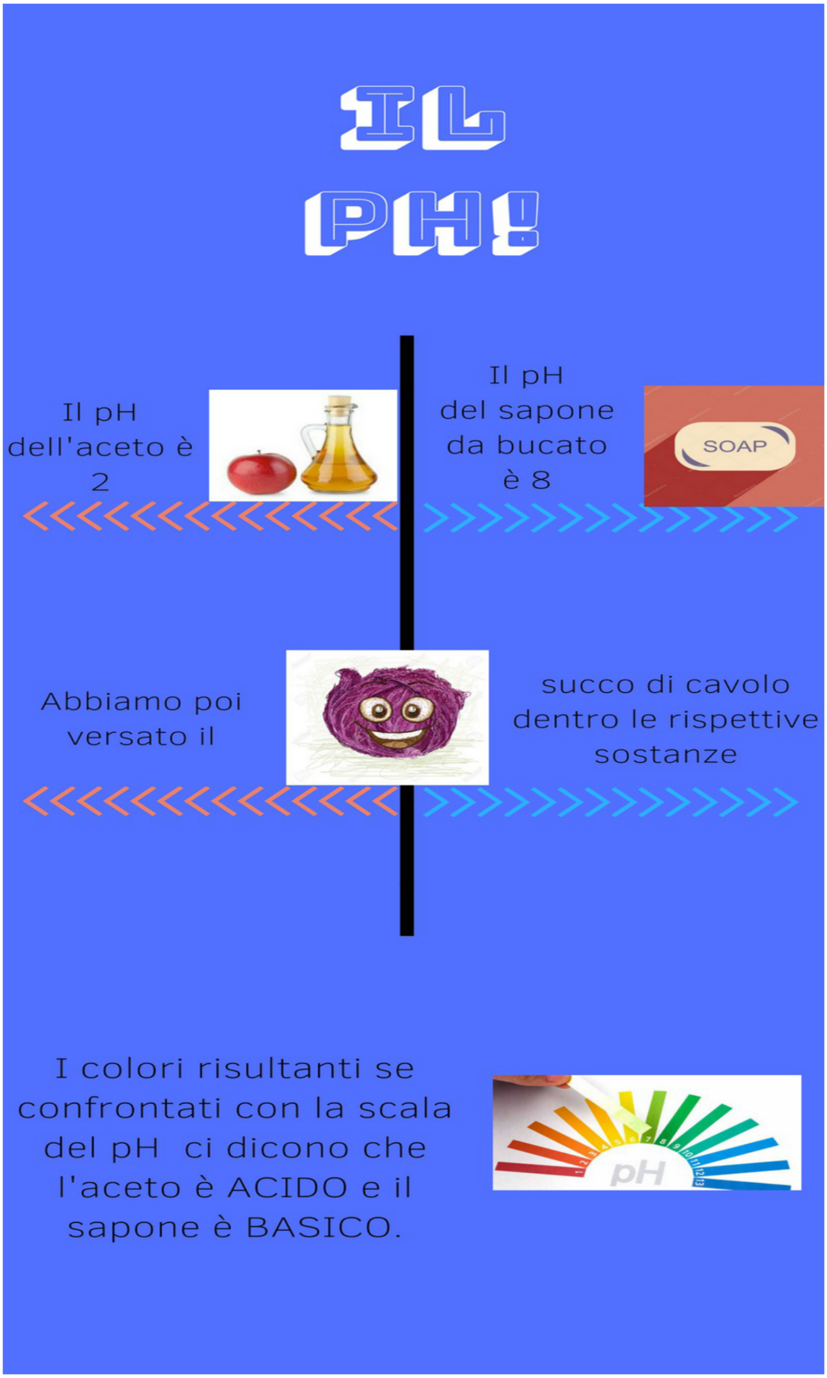


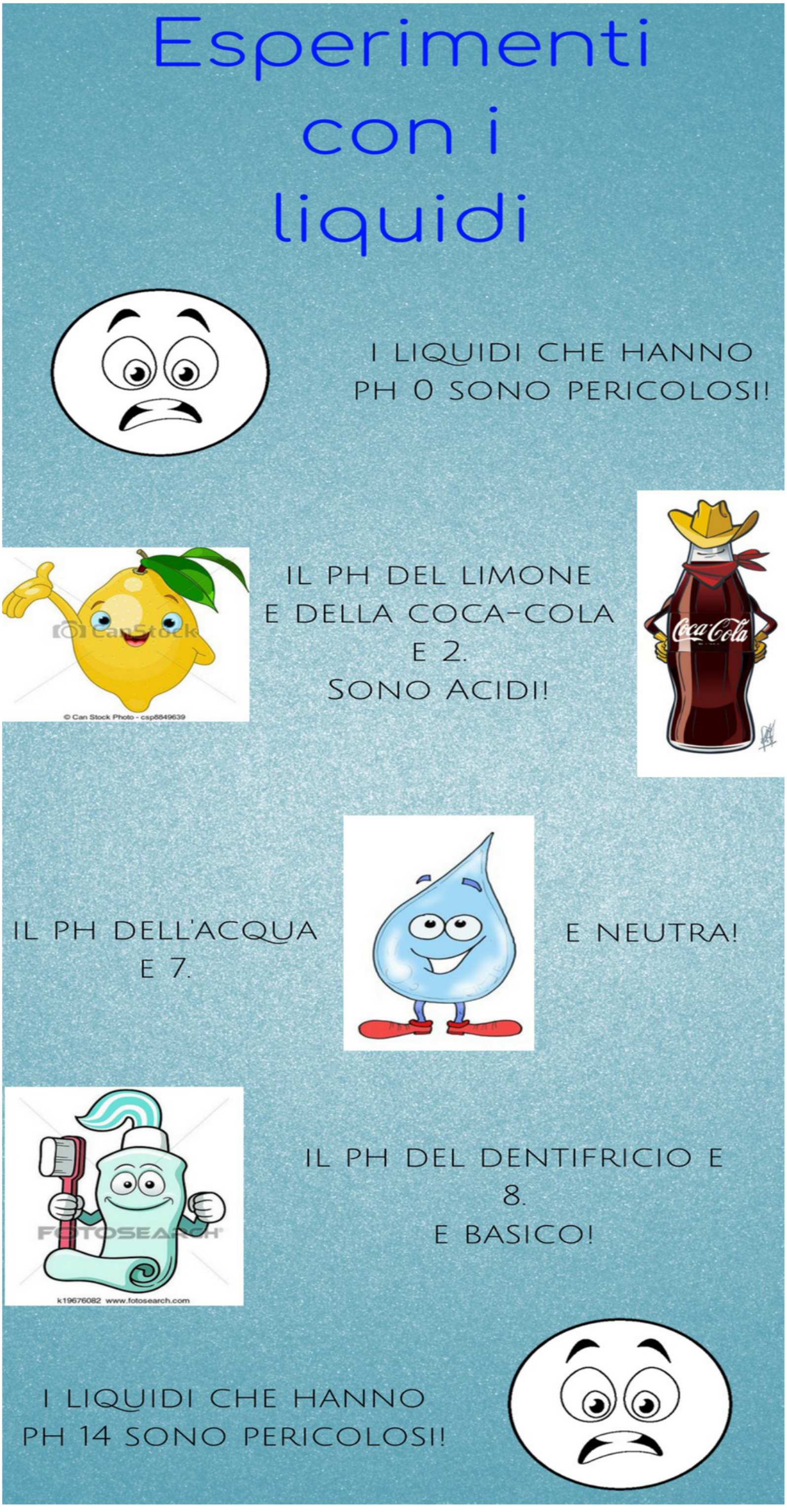
*In the order **Toothpaste, Detergent** and **Soap***



In the order **Toothpaste +** ***red cabbage juice***, **Detergent +** ***red cabbage juice*** and **Soap +** ***red cabbage juice***

A.5 Some infographics produced during experimentation by students




Esperimenti con i liquidi
I LIQUIDI CHE HANNO PH 0 SONO PERICOLOSI!
IL PH DEL LIMONE E DELLA COCA-COLA E 2. SONO ACIDI!
IL PH DELL'ACQUA E 7.
E NEUTRA!
IL PH DEL DENTIFRICIO E 8. E BASICO!
I LIQUIDI CHE HANNO PH 14 SONO PERICOLOSI!

Acidi e Basi

1



Abbiamo misurato il pH
del succo di pera.
E risultato 4!

2



Abbiamo misurato il pH
del detersivo.
E risultato 8!

Abbiamo poi versato il succo di
cavolo rosso dentro ad entrambi ed
il risultato è stato:



un colore verde come
questo che la scala del pH
ci dice che il liquido è
ACIDO.

un colore azzuro come
questo che la scala
del pH ci
dice che il liquido è
BASICO.

Abbiamo poi misurato il pH
della Coca-Cola che è 2.
Quindi ACIDA!


Acidi e basi
Attenzione ai liquidi con pH 0! Sono pericolosi!
Sia il limone che la Coca-Cola hanno pH 2 quindi sono acidissimi!
L'acqua è neutra! Il suo pH è 7!
Il dentifricio è basico perchè ha un pH di 8!
Attenzione ai liquidi con pH 14! Sono pericolosi!

ACIDI
E
BASI

MISURIAMO IL PH DEI LIQUIDI







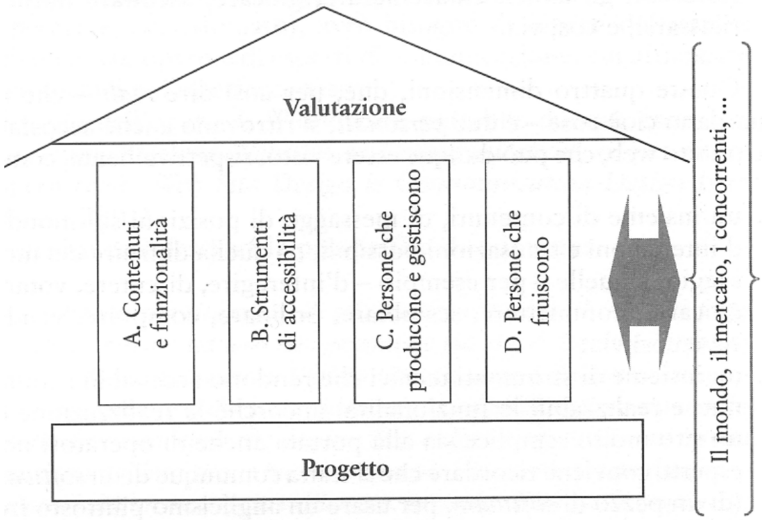
Abbiamo misurato il pH dell'aceto che è risultato 2!

Abbiamo poi versato il succo di cavolo rosso dentro all'aceto ed il risultato è un colore giallo-arancio come questo! Quindi l'aceto è ACIDO!

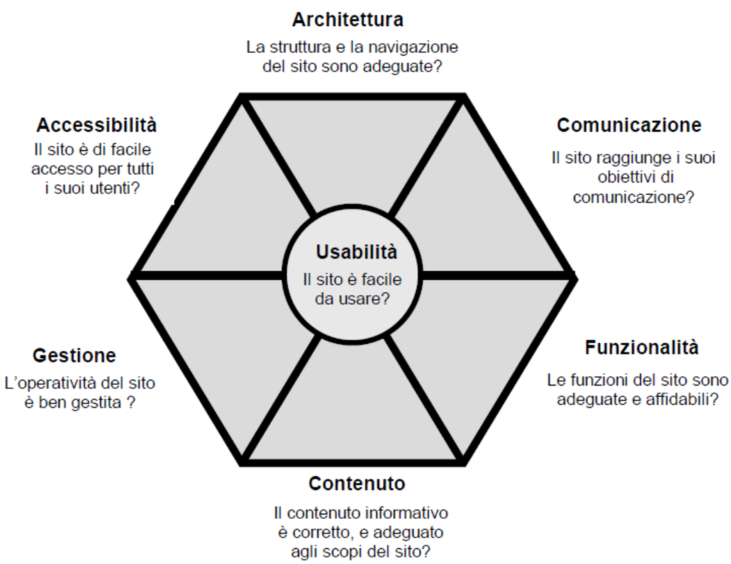
Abbiamo misurato il pH del sapone da bucato che è risultato 8!

Abbiamo poi versato il succo di cavolo rosso dentro al sapone ed il risultato è un colore azzuro come questo! Quindi il sapone è BASICO!

A.6 Tests schemes



Model of a website intended as a communication system (source: Cantoni, Di Blas & Bolchini, 2003)



Macrocharacteristics of the quality model (source: www.usabile.it)

A.7 Cronbach's Alpha – Test of Experimental group

Cronbach's Alpha	0,837332
Split-Half (odd-even) Correlation	0,803391
Split-Half with Spearman-Brown Adjustment	0,890978
Mean for Test	11,14917
Standard Deviation for Test	1,514155
KR21 (use only 0 and 1 to enter data for this)	6,208058
KR20 (use only 0 and 1 to enter data for this)	6,22757

Reliability Calculator
created by Del Siegle (del.siegle@uconn.ec

Questions	Subjects
6	182

	Question 1	Question 2	Question 3	Question 4	Question 5	Question 6
Subject1	2	2	2	2	2	2
Subject2	2	2	2	2	2	2
Subject3	2	2	2	2	2	2
Subject4	2	2	1	2	2	1
Subject5	2	2	2	2	2	2
Subject6	2	1	2	1	2	2
Subject7	2	2	2	2	2	2
Subject8	2	1	1	2	1	1
Subject9	2	2	2	2	2	2
Subject10	2	2	2	1	2	2
Subject11	2	2	2	2	2	2
Subject12	2	2	2	2	2	2
Subject13	2	2	2	2	2	2
Subject14	2	2	2	2	2	2
Subject15	2	2	2	2	2	2
Subject16	2	2	2	2	2	2
Subject17	2	2	2	2	2	2
Subject18	2	1	2	1	2	2
Subject19	2	2	2	2	2	2
Subject20	2	2	1	1	1	1
Subject21	2	2	2	2	2	2
Subject22	2	2	2	1	2	2
Subject23	2	2	2	2	2	2
Subject24	2	2	2	2	2	2
Subject25	2	2	2	2	2	2
Subject26	2	2	2	2	2	2
Subject27	2	2	2	2	2	2
Subject28	2	2	1	2	2	1
Subject29	2	2	2	2	2	2
Subject30	2	1	2	1	2	2
Subject31	2	2	2	2	2	2
Subject32	2	1	1	1	1	1
Subject33	2	2	2	2	2	2
Subject34	2	2	2	1	2	2
Subject35	2	2	2	2	2	2
Subject36	2	2	2	2	2	2
Subject37	2	1	1	1	1	1
Subject38	2	2	2	2	2	2
Subject39	2	2	2	1	2	2
Subject40	2	2	2	2	2	2
Subject41	2	2	2	2	2	2
Subject42	2	2	2	2	2	2
Subject43	2	2	2	2	2	2
Subject44	2	2	2	2	2	2

Subject45	2	2	1	2	2	1
Subject46	2	1	1	1	1	1
Subject47	2	2	2	2	2	2
Subject48	2	2	2	1	2	2
Subject49	2	2	2	2	2	2
Subject50	2	2	2	2	2	2
Subject51	2	2	1	2	2	1
Subject52	2	2	2	2	2	2
Subject53	2	1	2	1	2	2
Subject54	2	2	2	2	2	2
Subject55	2	1	1	1	1	1
Subject56	2	2	2	2	2	2
Subject57	2	2	2	2	2	2
Subject58	2	2	2	2	2	2
Subject59	2	2	1	2	2	1
Subject60	2	2	2	2	2	2
Subject61	2	1	2	1	2	2
Subject62	2	2	2	2	2	2
Subject63	2	1	1	1	1	1
Subject64	2	2	2	1	2	2
Subject65	2	2	2	2	2	2
Subject66	2	2	2	2	2	2
Subject67	2	2	1	2	2	1
Subject68	2	2	2	2	2	2
Subject69	2	1	2	1	2	2
Subject70	2	2	2	2	2	2
Subject71	2	1	1	1	1	1
Subject72	2	2	2	2	2	2
Subject73	2	1	1	1	1	1
Subject74	2	2	2	2	2	2
Subject75	2	2	2	1	2	2
Subject76	2	2	2	2	2	2
Subject77	2	2	2	2	2	2
Subject78	2	2	2	2	2	2
Subject79	2	2	2	2	2	2
Subject80	2	2	2	2	2	2
Subject81	2	2	1	2	2	1
Subject82	2	2	2	2	2	2
Subject83	2	1	1	1	1	1
Subject84	2	2	2	2	2	2
Subject85	2	2	2	1	2	2
Subject86	2	2	2	2	2	2
Subject87	2	2	2	2	2	2
Subject88	2	2	2	2	2	2
Subject89	2	2	2	2	2	2
Subject90	2	2	2	2	2	2
Subject91	2	2	1	2	2	1
Subject92	2	2	2	1	2	2
Subject93	2	2	2	2	2	2
Subject94	2	2	2	2	2	2
Subject95	2	2	2	2	2	2
Subject96	2	2	2	2	2	2
Subject97	2	2	2	2	2	2
Subject98	2	2	1	2	2	1

Subject99	2	2	2	2	2	2
Subject100	2	1	1	1	1	1
Subject101	2	2	2	2	2	2
Subject102	2	2	2	2	2	2
Subject103	2	2	2	2	2	2
Subject104	2	2	1	2	2	1
Subject105	2	2	2	2	2	2
Subject106	2	1	2	1	2	2
Subject107	2	2	2	2	2	2
Subject108	2	1	1	1	1	1
Subject109	2	2	2	2	2	2
Subject110	2	2	2	1	2	2
Subject111	2	2	2	2	2	2
Subject112	2	2	2	1	2	2
Subject113	2	2	2	2	2	2
Subject114	2	2	2	2	2	2
Subject115	2	1	1	1	1	1
Subject116	2	2	2	2	2	2
Subject117	2	2	2	1	2	2
Subject118	2	2	2	2	2	2
Subject119	2	2	2	2	2	2
Subject120	2	1	2	1	2	2
Subject121	2	2	2	2	2	2
Subject122	2	1	1	1	1	1
Subject123	2	2	2	2	2	2
Subject124	2	2	2	1	2	2
Subject125	2	2	2	2	2	2
Subject126	2	2	2	2	2	2
Subject127	2	2	2	2	2	2
Subject128	2	2	2	2	2	2
Subject129	2	2	1	2	2	1
Subject130	2	2	2	2	2	2
Subject131	2	1	2	1	2	2
Subject132	2	2	2	2	2	2
Subject133	2	1	1	1	1	1
Subject134	2	2	2	2	2	2
Subject135	2	2	2	1	2	2
Subject136	2	2	2	2	2	2
Subject137	2	2	2	2	2	2
Subject138	2	2	2	2	2	2
Subject139	2	2	2	2	2	2
Subject140	2	2	2	2	2	2
Subject141	2	2	2	2	2	2
Subject142	2	2	2	2	2	2
Subject143	2	2	2	2	2	2
Subject144	2	2	2	2	2	2
Subject145	2	2	1	2	2	1
Subject146	2	2	2	1	2	2
Subject147	2	2	2	2	2	2
Subject148	2	2	2	2	2	2
Subject149	2	2	2	2	2	2
Subject150	2	2	2	2	2	2
Subject151	2	2	2	2	2	2
Subject152	2	2	2	2	2	2

Subject153	2	2	2	2	2	2
Subject154	2	2	2	2	2	2
Subject155	2	2	2	2	2	2
Subject156	2	2	2	2	2	2
Subject157	2	2	2	2	2	2
Subject158	2	2	2	2	2	2
Subject159	2	1	2	1	2	2
Subject160	2	2	2	2	2	2
Subject161	2	1	1	1	1	1
Subject162	2	2	2	2	2	2
Subject163	2	2	2	1	2	2
Subject164	2	2	2	2	2	2
Subject165	2	2	2	2	2	2
Subject166	2	2	2	2	2	2
Subject167	2	2	2	2	2	2
Subject168	2	1	2	1	2	2
Subject169	2	2	2	2	2	2
Subject170	2	1	1	1	1	1
Subject171	2	2	2	2	2	2
Subject172	2	2	2	1	2	2
Subject173	2	2	2	2	2	2
Subject174	2	2	2	2	2	2
Subject175	2	2	2	2	2	2
Subject176	2	2	2	2	2	2
Subject177	2	1	2	1	2	2
Subject178	2	2	2	2	2	2
Subject179	2	1	1	1	1	1
Subject180	2	2	2	2	2	2
Subject181	2	2	2	1	2	2

A.8 Cronbach's Alpha – Test of Control group

Cronbach's Alpha	0,59057
Split-Half (odd-even) Correlation	0,602219
Split-Half with Spearman-Brown Adjustment	0,751731
Mean for Test	10,01923
Standard Deviation for Test	1,834398
KR21 (use only 0 and 1 to enter data for this)	3,593428
KR20 (use only 0 and 1 to enter data for this)	3,621761

Reliability Calculator
created by Del Siegle (del.siegle@uconn.e

Questions	Subjects
6	52

	Question 1	Question 2	Question 3	Question 4	Question 5	Question 6
Subject1	2	0	2	2	2	2
Subject2	2	2	2	2	2	2
Subject3	1	2	2	2	2	2
Subject4	1	0	1	2	2	1
Subject5	1	2	2	2	2	2
Subject6	1	1	2	1	2	2
Subject7	1	2	2	2	2	2
Subject8	1	1	1	2	1	1
Subject9	2	1	1	0	2	2
Subject10	2	2	1	1	2	2
Subject11	2	2	1	1	0	2
Subject12	2	2	2	1	2	2
Subject13	2	0	1	2	0	2
Subject14	2	2	2	2	2	2
Subject15	2	1	2	1	1	2
Subject16	2	2	2	2	2	2
Subject17	2	2	2	1	2	2
Subject18	2	1	1	1	2	2
Subject19	1	2	2	2	2	2
Subject20	2	2	1	1	1	1
Subject21	2	2	1	2	2	2
Subject22	2	2	2	1	2	2
Subject23	2	1	2	2	2	2
Subject24	1	1	2	1	2	2
Subject25	2	1	2	2	1	2
Subject26	1	2	2	2	2	1
Subject27	2	2	2	1	2	2
Subject28	2	2	1	2	2	1
Subject29	2	2	0	0	0	1
Subject30	2	0	1	1	2	2
Subject31	2	1	2	2	2	2
Subject32	2	0	1	1	1	1
Subject33	2	2	2	2	2	2
Subject34	2	2	2	1	2	2
Subject35	2	0	2	2	2	2
Subject36	2	2	1	1	2	2
Subject37	2	1	1	1	1	1
Subject38	2	2	2	2	2	2
Subject39	2	2	2	1	2	2
Subject40	2	2	2	2	2	2
Subject41	2	2	2	2	2	2

Subject42	2	2	2	2	2	2
Subject43	2	2	2	2	2	2
Subject44	2	2	2	2	2	2
Subject45	2	2	1	1	2	1
Subject46	2	1	1	1	1	1
Subject47	2	2	2	2	2	2
Subject48	2	2	2	1	2	2
Subject49	2	2	2	2	2	2
Subject50	2	2	2	2	2	2
Subject51	2	1	1	2	2	1
Subject52	2	1	2	2	1	1

ISBN: 978-606-37-0947-0